401B
401BR

OSCILLOSCOPE
Instruction Manual

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ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, NEW JERSEY, U. S. A.

TYPE

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401B 401BR OSCILLOSCOPE Instruction Manual

DU MONT

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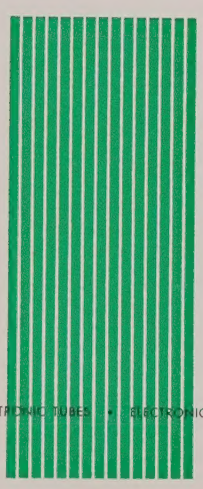

ELECTRONIC TUBES • ELECTRONIC INSTRUMENTATION • INDUSTRIAL TELEVISION • MILITARY ELECTRONICS • AUTOMOTIVE TEST EQUIPMENT • TWO WAY RADIO

ALLEN B. DU MONT LABORATORIES, CLIFTON, NEW JERSEY, U. S. A.

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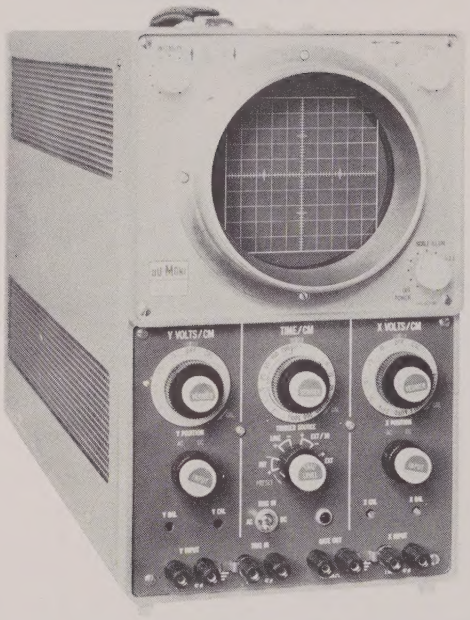


Figure 1-1a. Du Mont Type 401-B Oscilloscope

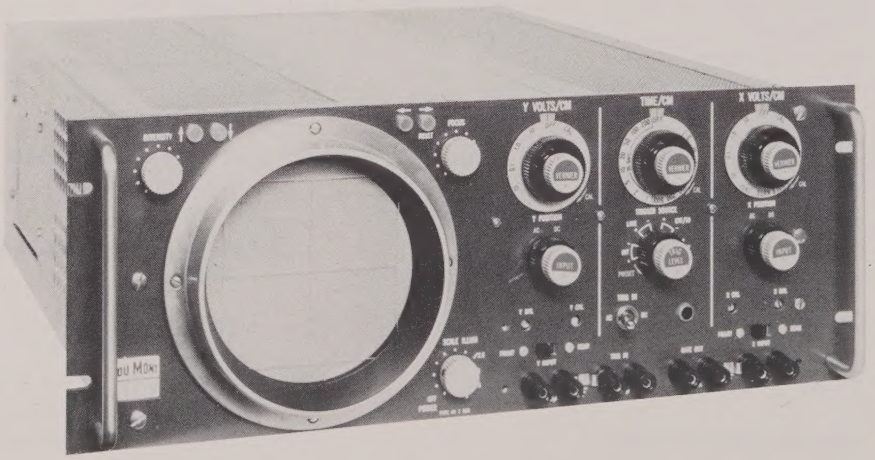


Figure 1-1b. Du Mont Type 401-BR Oscilloscope

SECTION I
TECHNICAL SUMMARY

1-1. INTRODUCTION

This manual of Operating and Maintenance instructions covers information on both the Type 401-B (bench model) and Type 401-BR (rack mounted) Oscilloscopes. Electrically, the two types are identical; mechanically, they differ in exterior appearance. These differences are clearly indicated in the text. Otherwise, references throughout the manual to the Type 401-B pertain also to the Type 401-BR.

1-2. PURPOSE

The Du Mont Type 401-B Oscilloscope is a measuring instrument designed to be used for almost any general application. The high gain of this instrument assures that it can be used directly with many types of transducers, while dc amplification provides that the lowest frequency portions of signals will be faithfully reproduced.

1-3. FEATURES

- K1931-P tight tolerance cathode-ray tube with 5000 volts over-all accelerating potential; screen aluminazation optional
- Provisions for balanced or single-ended vertical and horizontal input signals
- Identical frequency response and gain of both X and Y amplifiers extending from dc to 3 db down at 450 Kc at a sensitivity of 10 millivolts/cm
- Calibration voltage is provided for each amplifier
- Calibrated linear sweep rates from 200 milliseconds/cm to 5 microseconds/cm in fifteen steps of 2, 5, 10, and 20 sequence
- Uncalibrated linear sweep, continuously variable in rate from 1 second/cm to 1 microsecond/cm. Longest sweep time is 10 seconds full scale

- Provision for connection of external capacitance provided at rear of instrument for extension of sweep time
- Driven, automatic, or single (armed) sweep operation with automatic forward trace brightening
- Examination on the screen of any portion of signal expanded up to at least five times full scale without distortion
- Provision for Z-Axis (intensity) modulation
- Provisions for direct access to the deflection plates of the cathode-ray tube.
- Regulated high and low-voltage supplies
- Tube and component selection not required

1-4. LIST OF RECOMMENDED ACCESSORIES

TYPE OR PART NUMBER	DESCRIPTION
	FILTERS
4800 4511	Color filter, green for P1 and P2 screen
4800 4512	Color filter, blue for P11 or P7 screen
4800 4513	Color filter, amber for P7 screen
	PROBE AND KIT
4290	10:1 Attenuator Probe
4001	Sweep Rearming Kit
	TABLES
2601-A or 2602	Movable table, non-adjustable shelf Movable table, adjustable shelf
	TERMINAL ADAPTER
2592-B	Terminal Adapter, un-terminated, for use with BNC Type connector
	VIEWING ACCESSORY
276-C	Viewing hood

1-5. TECHNICAL SUMMARY

The electrical and physical characteristics of the Types 401-B and 401-BR are listed in Table 1-1 which follows.

TABLE 1-1
TECHNICAL SUMMARY
DU MONT TYPES 401-B AND 401-BR OSCILLOSCOPES

CATHODE-RAY TUBE DATA	
CRT	
Type	K1931-P1 tight tolerance CRT is normally supplied; P7 phosphor for long persistence low frequency or transient observation; P11 for photographic use; and P2 phosphor for combination visual and photographic use are also available; aluminazation optional
Over-all Accelerating Potential	5000 volts
Bezel	Light-proof bezel provides firm mount for an oscilloscope camera and permits ready interchange of filters and scales
CRT Scale	Engraved edge-lit scale having 10 cm by 10 cm graduations and appropriate color filter over face of tube. Scale Illumination control varies illumination level from zero to intensity adequate for photographic recording. Non-parallax scale optional
CRT DIRECT INPUT (Terminals are available at the rear of the instrument)	
X Axis	Deflection Factor: from 10 volts/cm to 14 volts/cm
Y Axis	Deflection Factor: from 10 volts/cm to 14 volts/cm

TABLE 1-1 (Continued)

CRT DIRECT INPUT—Continued

Z Axis	Positive pulse to cathode of CRT blanks trace. 15 volts needed into an impedance of approximately 1000 ohms coupled via 0.01 μf capacitor. Time constant is approximately 10 milliseconds

VERTICAL-DEFLECTION SYSTEM

BANDWIDTH

Direct Coupled	DC to 500 kilocycles; down 3 db $\pm$ 1 db at 500 kilocycles 6 centimeters of undistorted deflection at 1 megacycle
Capacitively Coupled	From 2 cycles to 500 kilocycles
Rise Time	0.8 microseconds with less than 2% overshoot

SENSITIVITY

Input Attenuation	Provided by a frequency compensated attenuator with steps from 10 millivolts/cm to 10 volts/cm, accurate to within 2% when set on any one step. An OFF position is included for dc balancing
Calibrated Operation	From 10 millivolts/cm to 10 volts/cm in four decade steps when VERNIER control is preset to CAL
Uncalibrated Operation	Continuously variable from 10 millivolts/cm to 100 volts/cm. VERNIER control permits 10 to 1 continuous sensitivity adjustments between the decade attenuator steps and extends the 10 volts/cm range to 100 volts/cm
Positioning Range	5 times full screen

INPUT DATA

Input Connectors	Combination binding posts spaced on $\frac{3}{4}$-inch centers to accommodate the Du Mont Type 2592-B shielded terminal adapter. Two binding post connectors are provided for balanced vertical input and a ground binding post and connector strap are provided for single-ended amplifier operation
Input Impedance	
Single-ended	1 megohm, constant within $\pm$ 3% at all attenuator settings; nominally 47 pf ($\mu\mu$f), constant within $\pm$ 5% from range to range
Balanced	2 megohms shunted by less than 40 pf ($\mu\mu$f)
Input Coupling	
Single-ended	Direct or through capacitor of 600-volt rating to amplifier
Balanced	10 millivolts/cm range (DC only); adjustable to 100 millivolts/cm (push-pull)

COMMON MODE

Rejection Ratio	Nominally 120:1, always better than 100:1 (40 db)
Maximum Signal	Common mode signal must not exceed $\pm$ 3 volts dc plus peak ac

PHASE SHIFT

Features	Vertical and horizontal amplifiers are identical. At maximum gain, the phase shift between the orthogonal systems is adjustable to $\pm$ 1 degree at any point from dc to 300 Kc. When adjusted to 0° at 200 Kc, the phase shift differential is $\pm$ 2° from dc to 250 Kc

HORIZONTAL-DEFLECTION AMPLIFIER

(Same characteristics as the Vertical Deflection Amplifier)

SYNCHRONIZATION

TRIG INPUT COUPLING

AC	80 cycles to 500 Kc minimum

TABLE 1-1 (Continued)

TRIG INPUT COUPLING—Continued

DC	Direct coupled to 500 Kc to: (1) preserve very low frequencies, (2) maintain the initial starting point of the trace on the scale for a given trigger level setting; and (3) avoid effects of random repetition rate trigger sginals

SLOPE LEVELING

Polarity	Selection of positive or negative slopes on Internal, Line, or External triggering is available
Trigger Level	A range of ± 12 volts for direct External Trigger Input or 1½ times full scale on internal triggering. Preset position provides fixed optimized sensitivity. On External/10 Trigger Source, the leveling range is extended to ± 120 volts.

TRIGGER SENSITIVITIES

Internal	Signals will synchronize from ½ centimeter of vertical signal on driven and single sweep position. Less than 2 millimeters are required in the auto triggering position. A choice of trigger polarity (slope) is available
Line	Line frequency synchronization can be selected in either polarity (slope) and the triggering point may be shifted with the trigger level control
External	0.25 volt peak-to-peak (250 millivolts peak-to-peak) from dc to approximately 300 Kc will synchronize the sweep The 10:1 external trigger attenuator will permit trigger signals greater than 200 volts peak-to-peak (± 100 volts) to be useful. Trigger leveling, polarity selection, and ac or dc coupling are included. 0.5 volt peak-to-peak will trigger the sweep from dc to over 500 Kc in Driven and Single Sweep positions. Approximately 0.4 volt peak-to-peak is required in Auto Triggering operation

AUTOMATIC TRIGGERING

Features	Auto triggering is available in conjunction with preset or vernier trigger leveling, on internal, external, and line trigger sources. Auto triggering simplifies synchronization and provides a continuous base line at a frequency of approximately 50 cycles

SWEEP CIRCUIT

TIME BASE

Calibrated	From 200 milliseconds/cm to 5 microseconds/cm in 15 steps. Step sequence in 1, 2, 5, and 10. An "off" position is included
Uncalibrated	Continuously variable, uncalibrated between ranges and extends the 200 milliseconds/cm range to 1 second/cm (10 seconds full scale)
Accuracy	Normally within 3%; always within 5% (full scale)
Sweep Expansion	5 times expansion. Extends fastest sweep rate to 1 microsecond/cm within ± 10%
Expanded Sweep Positioning	Sufficient to position any full scale portion of the expanded trace (50 cm) on the screen
Extension of Lower Sweep Rates	External Sweep Capacitor Terminals are provided on the rear panel for slower sweeps. See Section 2, Operation, for further details
Single Sweep	The single sweep mode permits but one driven sweep of the time base to appear on the screen until the sweep is reset. A reset adapter kit, the Du Mont Type 4001, is available for use with external resetting contact closures (as may be found on mechanical devices, Du Mont oscilloscope camera shutters, etc.)
Electronic Shutter	Controlled exposure brightening for multiple trace X-Y displays through use of driven sweep. This feature may be switched out by setting the sweep to the "off" position

TABLE 1-1 (Continued)

OTHER CHARACTERISTICS

BEAM POSITION INDICATORS

Features	Four indicator lamps are on the front panel to alert the operator as to the direction of the beam when it is positioned off the screen. The right-hand indicating lamp also functions as a reset indicator when used in conjunction with the single sweep mode

UTILITY SIGNALS

Gate Out	Negative gate coincident with sweep time is available on a front panel binding post. Amplitude is more than 5 volts negative into an impedance of 10,000 ohms
10-Volt DC Out	A 10-volt, high impedance dc voltage is available at the rear panel to facilitate triggering from external contact closures

REAR TERMINALS ON RACK-MOUNTED UNIT

Features	Front panel input terminals are duplicated at the rear of the rack-mounted unit. Front/rear switching is provided on the X and Y amplifier inputs to allow choice of either front or rear connections. Input capacities are higher than the bench unit at the external trigger input and the rear terminals of the X and Y inputs Universal binding post type connectors are used at the rear of the rack-mounted units

AMBIENT TEMPERATURES

Operating	From 0°C to + 40°C. The 401-BR incorporates a thermal cutout to protect the unit when rack cooling is insufficient. Adequate ventilation and clearance around unit must be provided in rack installation to assure intake air below the specified ambient temperature
Storage	From — 20°C to + 85°C

INTERNAL CALIBRATOR

Features	Line frequency trapezoidal wave signal injected into the amplifier behind the attenuator to standardize gain. Accuracy nominally 1%, always within 2%

POWER SUPPLY

POWER REQUIREMENTS

Line Voltage	From 103.5 to 127.5 volts or from 207 to 255 volts at 60-cycle line
Line Frequency	Operation from 48 through 1000 cycles
Power	230 watts average; 250-volt amperes at 115-volt, 60-cycle line
Fuses	115-volt operation, 3 amperes 230-volt operation, 1.5 amperes
DC Power Supplies	Electronically regulated

PHYSICAL CHARACTERISTICS

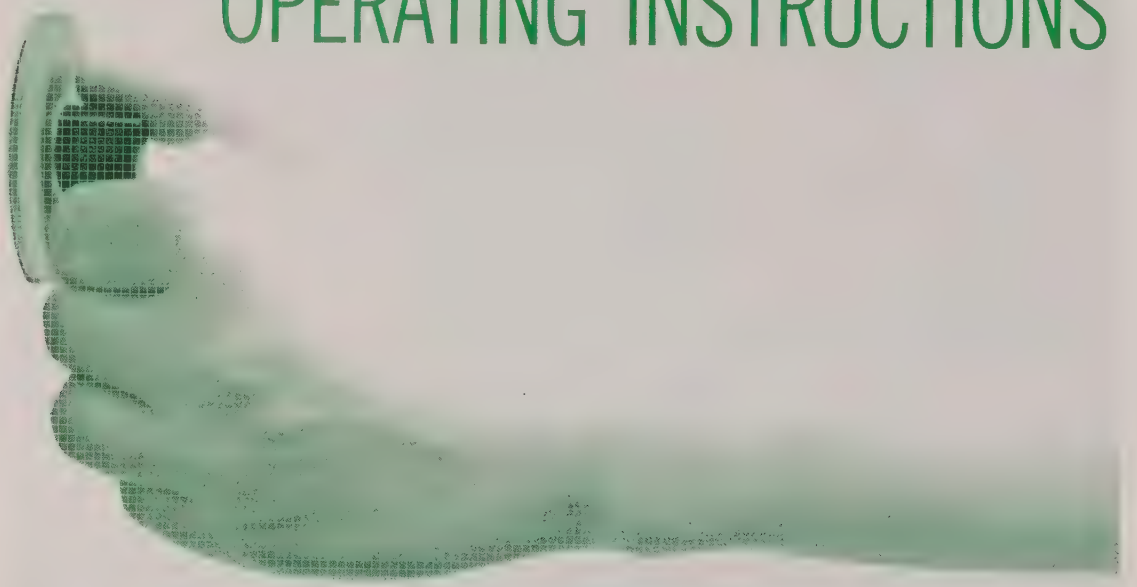
BENCH MODEL

Height	15½ inches	(39.4 cm)
Width	8¾ inches	(22.3 cm)
Depth	23¼ inches	(59.2 cm)
Weight	45 pounds	(20.4 kg)

RACK-MOUNTED MODEL

Height	7 inches	(17.8 cm)
Width	19 inches	(48.4 cm)
Depth	23⅛ inches 22 inches behind panel	(58.7 cm) (55.0 cm)
Weight	45 pounds	(20.4 kg)

SECTION II
OPERATING INSTRUCTIONS



2-1. GENERAL

The Du Mont Types 401-B and 401-BR Oscilloscopes are shipped with all tubes in place and ready to operate. Since these instruments are portable, no special installation procedure is required. The rack-mounted model has a front-panel 19 inches wide by 7 inches high for mounting the instrument in a standard relay rack or cabinet. Mounting holes are provided on each side of the 401-BR for the attachment of slides.

Normally the Type 401-B or 401-BR may be placed where most convenient for viewing while at the same time maintaining short signal leads. Although shielding has been provided, operation in very strong magnetic fields may cause spurious deflections and should be avoided. Reorientation or additional shielding of the instrument may be necessary to minimize the effects of such fields.

The instrument is intended for operation from a 48 through 1000 cycles, single-phase, 115/230-volt power source and will operate satisfactorily with line voltage variations of $\pm$ 10%.

Numerous accessory components are available from the Allen B. Du Mont Laboratories, Inc., to extend the usefulness of these oscilloscopes. See Section 1 for further details.

2-2. THERMAL CUTOUT (Type 401-BR only)

A thermal cutout switch is connected in series with one side of the power line in the rack-mounted version of the Type 401-B. When the interior temperature of the instrument exceeds the safety limit, the thermal cutout switch will trip, removing power from the unit. It will reset itself when the interior temperature drops to a safe value. Possible causes of overheating are restriction of air circulation or high ambient temperature.

2-3. PRECAUTION AGAINST SCREEN BURNING

A sharply focused spot of high intensity and small area should not be permitted to remain stationary on the screen for any length of time.

Under such conditions, the entire beam energy is concentrated over a small area, thus subjecting the screen material to burning and discoloration. This condition is most likely to exist when using the unit for X-Y plotting with the INTENSITY turned up, and no signal inputs. The INTENSITY LIMIT control R3119 located on the rear panel, may be adjusted to limit beam current to a safe value.

2-4. ILLUMINATED SCALE

The adjustable scale lighting control labeled SCALE ILLUM may be adjusted to suit the lighting conditions of the room or the f/number on the oscilloscope camera. The color filter supplied is tinted to provide the maximum trace contrast in the presence of room light. The colored filter should be mounted next to the cathode-ray tube so it does not block light from the calibrated scale, and should be removed when photographing the display.

The scale is accurately scribed in centimeters. These scale markings and the calibrated fixed attenuator markings and sweep rates, can be used to convert deflection in centimeters into volts and seconds. Vertical and horizontal sensitivities are accurately calibrated in volts per centimeter and TIME/CM switch settings are accurately calibrated in seconds per centimeter, which when multiplied by the number of centimeters of deflection give the voltages and seconds.

2-5. BEAM POSITION INDICATORS

Four indicator lamps located above the bezel indicate the position of the beam on the CRT screen. The two beam indicators on the left of the bezel function with the vertical movement of the beam, and the two on the right function with the horizontal. When one of the indicator lamps light, it indicates the direction in which the display is positioned off screen thus indicating the direction in which to turn the POSITION control to return the display to the screen. The indicators also enable the display to be positioned on screen when the INTENSITY level is set so low that the trace is invisible.

The right indicator lamp with RESET lettered beneath it is used during single sweep operation. When lit, it indicates the sweep requires rearming. Refer to Section 2-14c for further details.

2-6. FIRST TIME OPERATION

a. Instructions

To place the instrument in operation, plug the power cord into the proper grounded power source and turn INTENSITY control counterclockwise. Rotate the SCALE ILLUM control clockwise to apply power. Allow approximately 10 minutes for the instrument to warm up. In the instructions which follow, the words in capital letters within the text, indicate front-panel controls, connectors or settings. A brief description of the front-panel controls and connectors is given in Figure 2-1.

b. Initial Control Settings

The operator is advised to follow the specific instructions and sequence of operation as outlined in this Section. Set the various front-panel controls as indicated in Table 2-1. A pattern as indicated in Figure 2-2 should appear on the screen. At this time the operator may familiarize himself with the various controls and their effect on the built-in calibrator signal.

TABLE 2-1
INITIAL CONTROL SETTING

CONTROL	SETTING
Y VOLTS/CM	CAL
TIME/CM	2 MS/CM
X VOLTS/CM	AUTOmatic Sweep
VERNIERS (all three)	CAL
X & Y POSITION	Centered
X & Y INPUT	AC
TRIGGER SOURCE	+ INT
TRIG LEVEL	PRESET
TRIG IN	AC
INTENSITY	Suitable brightness
FOCUS	Sharp trace

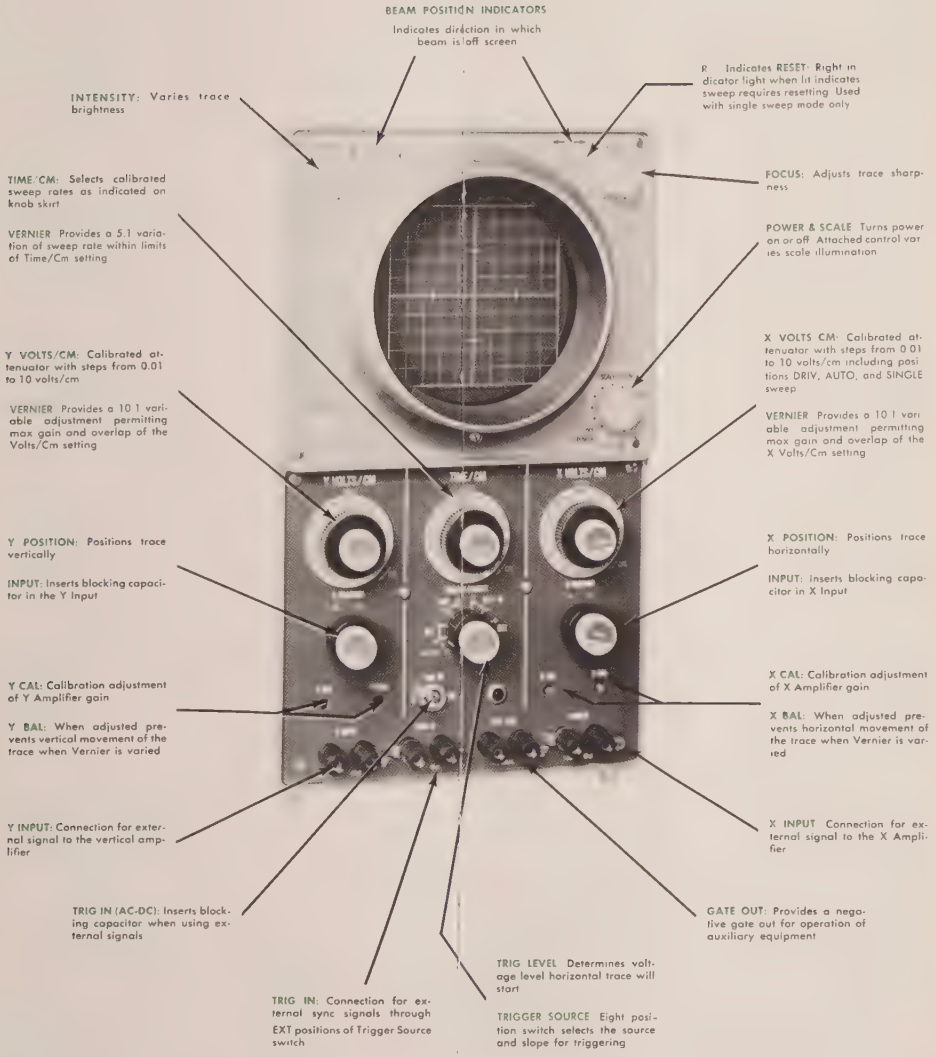

BEAM POSITION INDICATORS
Indicates direction in which beam is off screen
R Indicates RESET. Right indicator light when lit indicates sweep requires resetting. Used with single sweep mode only
INTENSITY: Varies trace brightness
FOCUS: Adjusts trace sharpness
TIME/CM: Selects calibrated sweep rates as indicated on knob skirt
VERNIER Provides a 5:1 variation of sweep rate within limits of Time/Cm setting
POWER & SCALE Turns power on or off. Attached control varies scale illumination
X VOLTS CM: Calibrated attenuator with steps from 0.01 to 10 volts/cm including positions DRIV, AUTO, and SINGLE sweep
Y VOLTS/CM: Calibrated attenuator with steps from 0.01 to 10 volts/cm
VERNIER Provides a 10:1 variable adjustment permitting max gain and overlap of the Volts/Cm setting
VERNIER Provides a 10:1 variable adjustment permitting max gain and overlap of the X Volts/Cm setting
Y POSITION: Positions trace vertically
INPUT: Inserts blocking capacitor in the Y Input
X POSITION: Positions trace horizontally
INPUT: Inserts blocking capacitor in X Input
Y CAL: Calibration adjustment of Y Amplifier gain
X CAL: Calibration adjustment of X Amplifier gain
Y BAL: When adjusted prevents vertical movement of the trace when Vernier is varied
X BAL: When adjusted prevents horizontal movement of the trace when Vernier is varied
Y INPUT: Connection for external signal to the vertical amplifier
X INPUT Connection for external signal to the X Amplifier
TRIG IN (AC-DC): Inserts blocking capacitor when using external signals
GATE OUT: Provides a negative gate out for operation of auxiliary equipment
TRIG LEVEL Determines voltage level horizontal trace will start
TRIG IN: Connection for external sync signals through EXT positions of Trigger Source switch
TRIGGER SOURCE Eight position switch selects the source and slope for triggering

Figure 2-1. Function of Controls and Connectors

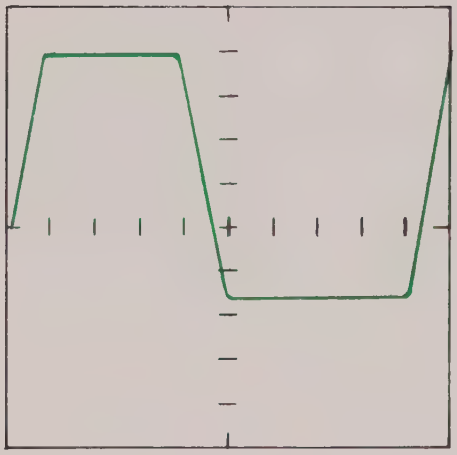


Figure 2-2. Calibrator Waveform Display

2-7. EFFECT OF THE AC/DC SWITCHES

Three separate AC/DC switches are employed in the Type 401-B Oscilloscope. Each switch permits the choice of retaining the dc level of the input signal or blocking the dc component of the input signal by inserting a blocking capacitor, one each in series with the input of the vertical and horizontal deflection amplifiers, and one in the input of the Trig Amplifier and Level Selector V210.

Separate INPUT switches (S111 and S121) select the desired AC/DC position for signals applied to the vertical and horizontal amplifiers. The TRIG IN switch (S211) selects the desired AC/DC position for application of all signals to the trigger circuit.

When either of these switches are set in the AC position, the effect of the dc component is excluded from the display. When set in the DC position, the ac signal and dc level of the waveform can be noted. The dc component will cause the entire display to rise or fall on the screen.

Reset switches to the AC position.

2-8. EFFECT OF THE FRONT-PANEL BAL CONTROLS

a. Y Bal

Set the Y VOLTS/CM switch to OFF and turn the Y VERNIER control counterclockwise. The reference trace on the screen should not drift vertically while rotating the VERNIER control throughout its range.

If trace shifts vertically, proceed as follows:

1. Turn VERNIER control to minimum.
2. Position trace to center of screen.
3. Turn VERNIER control to maximum.
4. Adjust the Y BAL control to bring trace back to center of screen.
5. Repeat this procedure until no depositioning of the trace is noted when the VERNIER control is rotated throughout its range.

Reset the Y VOLTS/CM switch and the VERNIER control to Cal.

b. X Bal

Set the X VOLTS/CM switch to OFF and turn the X VERNIER control counterclockwise. The reference trace on the screen should not drift horizontally while rotating the VERNIER control throughout its range.

If trace shifts horizontally, repeat steps 1 through 5 in Paragraph 2-8a above, using the X BAL and X VERNIER controls.

Reset the X VOLTS/CM switch and VERNIER control to CAL.

2-9. EFFECT OF THE Y VOLTS/CM SWITCH

With a signal of approximately 0.5 volt peak-to-peak applied to Y INPUT, turn the Y VOLTS/CM control to positions both to the right and left of the 0.1 setting. Notice that when the control is set to the higher number setting, the amplitude of the waveform is reduced and vice versa.

Reset the Y VOLTS/CM switch to 0.1 position, and turn its VERNIER control counterclockwise. Notice that counterclockwise movement of the VERNIER control decreases the amplitude of the signal being displayed and clockwise rotation increases the amplitude. When the VERNIER control is in the fully clockwise or CAL position, the signal is restored to its original calibration. Thus, it is seen when a given voltage is applied to Y INPUT, the Y VOLTS/CM and VERNIER controls are used for adjusting the amplitude of the resulting vertical deflection. Remove input signal and reset Y VOLTS/CM switch to CAL.

2-10. EFFECT OF THE TRIGGER SOURCE SWITCH

The TRIGGER SOURCE switch permits selection of the source and polarity of the sweep triggering signal.

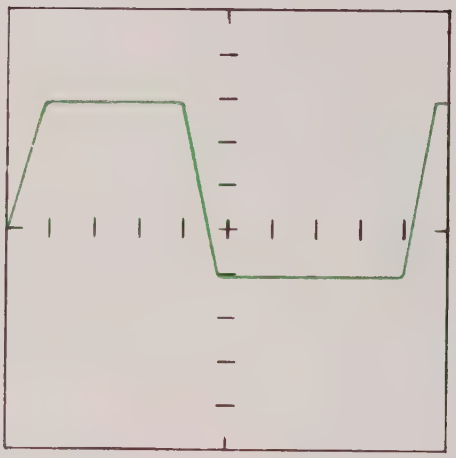


Figure 2-3. Trigger Source Switch Set to +INT

a. Positive Polarity (+Int)

Set front-panel controls in accordance with Table 2-1, except place the X VOLTS/CM switch in DRIVen and adjust Y VERNIER control for 4 centimeters of vertical deflection. Observe the left side or beginning of the trace. Notice that it starts during the rising portion of the waveform indicating that the sweep is triggered at a time when the slope of the waveform is positive. See Figure 2-3.

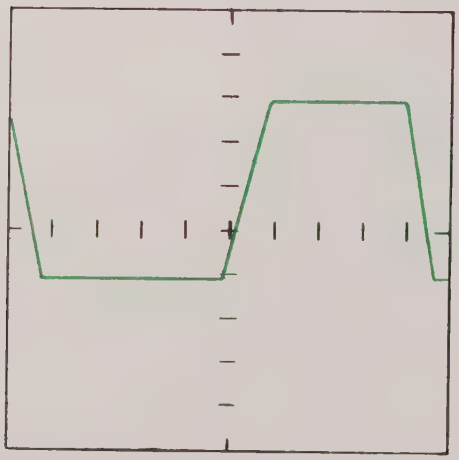


Figure 2-4. Trigger Source Switch Set to —INT

b. Negative Polarity (—Int)

Reset TRIGGER SOURCE switch to — INT and notice that the waveform appears to have turned upside down. In the — INT position, the trace begins on the falling portion of the waveform indicating that the sweep is triggered at a time when the slope of the waveform is negative. See Figure 2-4.

2-11. EFFECT OF THE TRIG LEVEL CONTROL

The TRIG LEVEL control permits selection of specific voltage the triggering signal must exceed before the sweep fires. A preset position on the TRIG LEVEL control permits ready availability of a stable, resettable, sensitive trigger level which will perform 90% of all triggering.

a. AC Triggering Mode

The TRIG LEVEL control determines the point on the waveform where the display starts.

1. Set the TRIGGER SOURCE switch to + INT, and notice that the display starts on the rising portion of the waveform where the slope is positive.

2. Rotate the TRIG LEVEL control slowly in the clockwise direction and observe that as the control switches from the PRESET position, the trace disappears. As the control is rotated more in the clockwise direction, the display reappears and the start of the display shifts to fire on the higher portion of the waveform. See Figure 2-5.

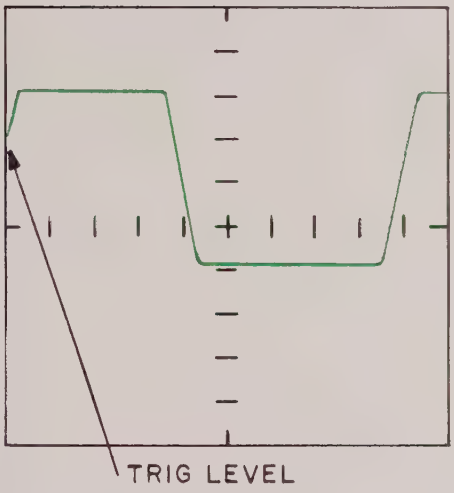


Figure 2-5. Effect of Trig Level Control when Slope is Positive

3. Rotate the TRIG LEVEL control slowly in the counterclockwise direction and observe that the display starts on the lower part of the waveform. When in the PRESET position, the original calibrated waveform is restored. See Figure 2-6.

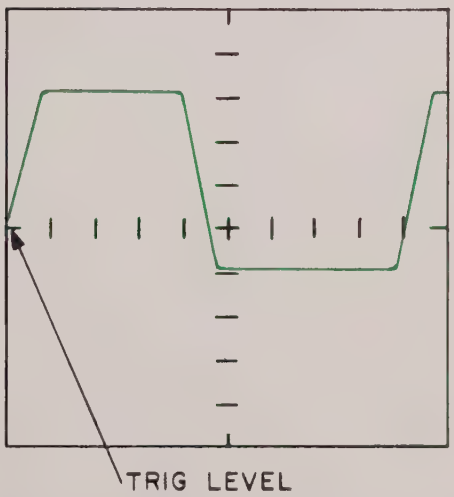


Figure 2-6. Effect of Trig Level Control when Slope is Positive

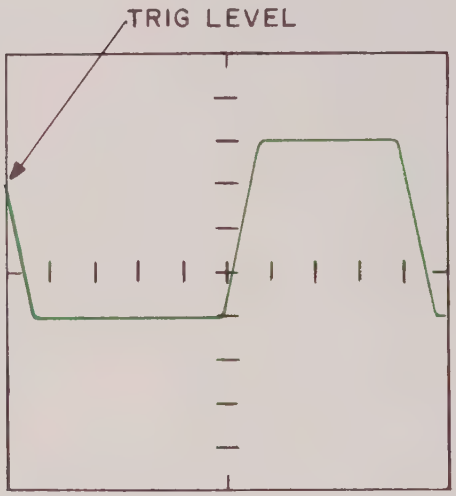


Figure 2-7. Effect of Trig Level Control when Slope is Negative

4. Set the TRIGGER SOURCE switch to — INT, and notice that the waveform appears to have turned upside down. The display is now beginning during the falling part of the waveform where the slope is negative.
5. Rotate the TRIG LEVEL control slowly in the clockwise direction and observe that the display starts on the higher portion of the waveform. See Figure 2-7.

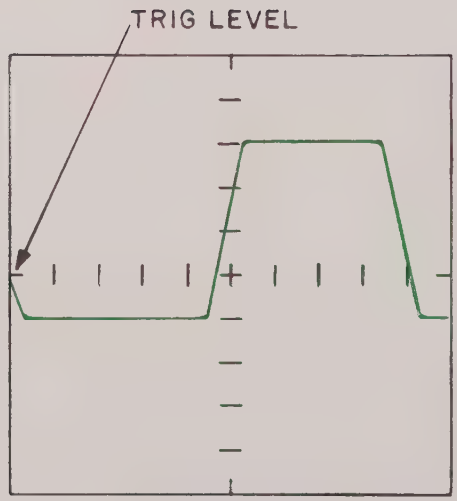


Figure 2-8. Effect of Trig Level Control when Slope is Negative

6. Rotate the TRIG LEVEL control slowly in the counterclockwise direction and observe that the display starts on the lower portion of the waveform. See Figure 2-8.

7. Reset TRIG LEVEL control to PRESET and TRIGGER SOURCE switch to + INT.

8. Set X VOLTS/CM switch to DRIVen Sweep and rotate Y VERNIER control to give a pattern of 3 centimeters of vertical deflection. Rotate the Y POSITION control back and forth observing the left side of the display as it is positioned up and down. Notice that for any setting of the TRIG LEVEL control, the trace always starts at the same point on the waveform regardless of the setting of the Y POSITION control. See Figures 2-9 and 2-10.

Display positioned upward

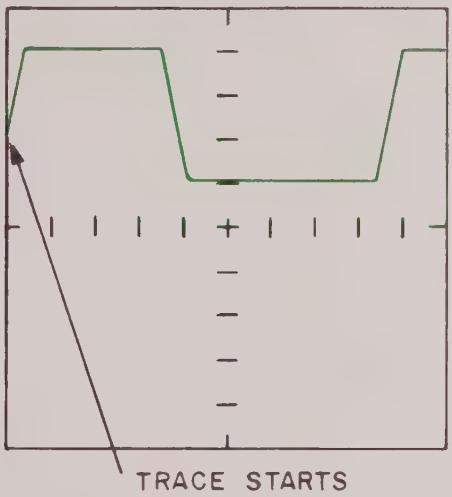


Figure 2-9. Vertical Positioning in the AC Mode

Display positioned downward

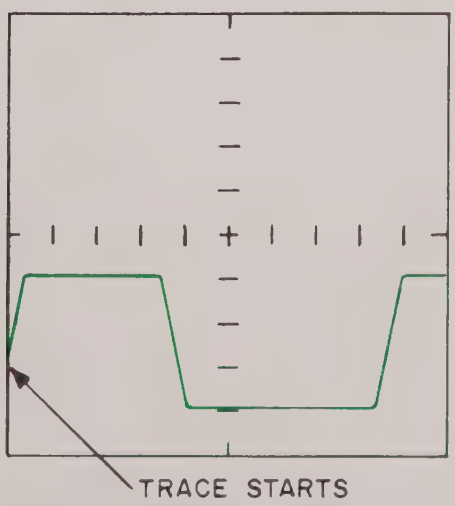
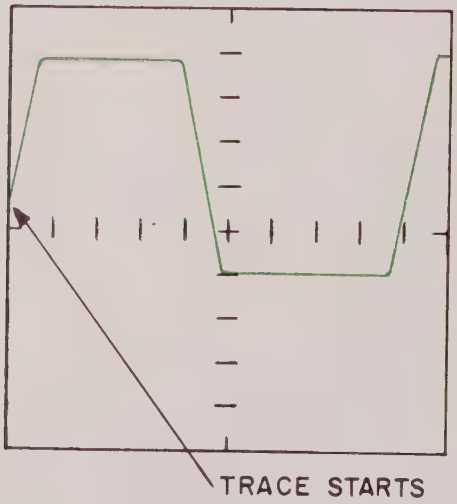


Figure 2-10. Vertical Positioning in the AC Mode

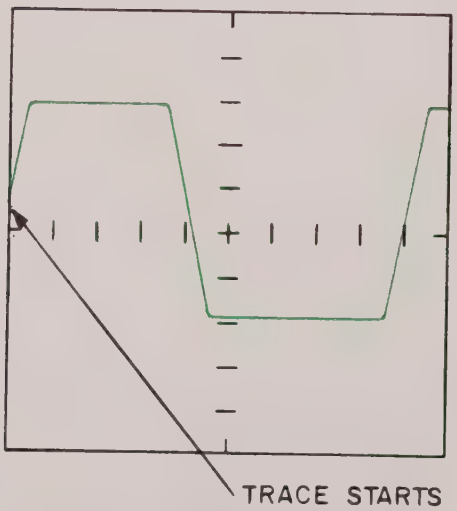
b. DC Triggering Mode

1. Set TRIG IN switch to DC. You are now triggering in the DC mode. Slowly turn the TRIG LEVEL control throughout its range observing the left side of trace. Note that the results are similar to those obtained when using AC mode. Set the TRIGGER SOURCE switch to — INT and again operate the TRIG LEVEL control. Note again that the results are similar to those obtained when using the AC mode.
2. Reset TRIGGER SOURCE switch to + INT, TRIG LEVEL control to PRESET, and Y VERNIER control to CAL.
3. Rotate Y POSITION control throughout its range observing the left side of the display as it is positioned up and down. Notice that for a given setting of the TRIG LEVEL control, the trace starts at the same point on the *Scale* regardless of the setting of the Y POSITION control. If you position the display above or below the setting, the trace will disappear. See Figures 2-11, 2-12, and 2-13.



Display positioned upward

Figure 2-11. Vertical Positioning in the DC Mode



Display centered

Figure 2-12. Vertical Positioning in the DC Mode

Display positioned downward

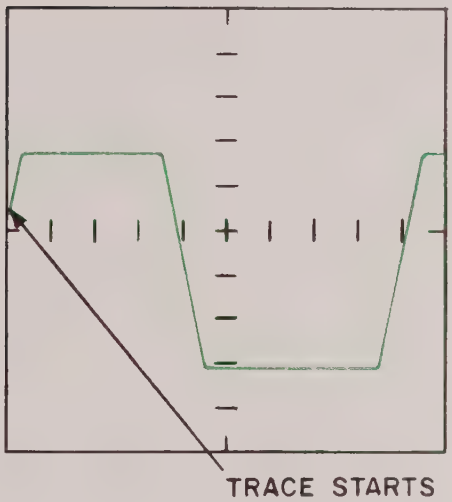


Figure 2-13. Vertical Positioning in the DC Mode

c. Summary of AC and DC Triggering Modes

In summary, the following statements may be made to compare the AC and DC modes of triggering.

1. When using the AC mode, the TRIG IN switch is set to AC, the trace always starts at the same point on the *Waveform* for a given TRIG LEVEL control setting regardless of the vertical positioning.
2. When using the DC mode, the TRIG IN switch is set to DC, the trace always starts at the same point on the *Scale* for a given setting of the TRIG LEVEL control regardless of the vertical positioning.
3. The DC mode is especially useful for viewing waveforms which change very slowly and which are therefore discriminated against by the low-frequency cutoff of the AC position (80 cps). Because of the coupling network time constant in the AC mode, signals having random repetition rates are sometimes viewed more stably in the DC mode.

2-12. OPERATING HINTS FOR THE VERTICAL DEFLECTION CHANNEL

a. Applying a Signal to the Oscilloscope

Observe the following precautions when applying signals to the oscilloscope:

1. Avoid errors in readings due to stray coupling between circuits, particularly in the signal lead. As a rule, do not use long unshielded leads for applying signals to the oscilloscope. This fact holds for the audio-frequency spectrum, except possibly when making measurements on low-impedance circuits at very low frequencies. When shielded leads are used, the shields should be grounded to the oscilloscope chassis and to the chassis of the equipment being tested. For many applications, coaxial cables are recommended.

2. In broadband applications, it may be necessary to terminate a coaxial cable with a resistance equal to its characteristic impedance. This is done to prevent standing waves or ringing (high-frequency damped oscillations). As the length of the cable is increased, the necessity for proper termination is generally inserted at the oscilloscope end of the cable, although many signal sources may require an additional termination at the other end of the cable. Refer to the accessory section of your Du Mont catalog for a listing of cables, terminating resistors and pads.

3. To avoid erroneous results, the operator should simulate the actual operating conditions of the equipment being tested. For example, the equipment should work into a load impedance equal to that which it will see in actual use.

4. Consider the effect of loading upon the signal source due to the input impedance of the oscilloscope. The input impedance can be represented by a resistance shunted by a capacitance. The effective value of this resistance and capacitance is indicated on the front panel. However, the operator should be aware that even with a few feet of cable in the input circuit, the loading capacitance on the circuit under investigation might be as high as 100 pf ($\mu\mu$f) or more.

5. There are cases when connecting the input of the oscilloscope to a signal source, the effect of loading the source is not negligible. To minimize this loading, a probe may be used in the manner described in the paragraph entitled "Use of Probes".

b. Input Coupling

There are times when it is neither necessary nor desirable to display the dc component of the input waveform. A capacitor placed in series with the input connector will exclude the dc component while simultaneously permitting the ac component to be displayed. This is accomplished when either of the INPUT (AC/DC) switches or the TRIG IN switch is set to AC.

Care must be exercised when applying a fast rise, high-frequency signal to the input connector. It will be necessary to match and properly terminate the coaxial cable applying the signal to the oscilloscope.

c. Single-Ended Y Input

Signals to be observed are connected to the vertical channel through the Y INPUT terminal and ground. Y INPUT (AC/DC) switch permits capacitive or direct coupling of the signal to the compensated attenuator. The terminals for direct connection to the deflection plates are accessible at the rear of the cabinet. See Paragraph 2-16 entitled "Deflection Plate Connections" for further details.

d. Use of Balanced Input

For balanced input, remove the link from the normally grounded Y INPUT terminal. The Y VOLTS/CM switch must be set to the 0.01 DC position. If there is an in-phase signal (common mode) riding on the balanced-input signal, the permissible input voltage (dc plus peak ac) will be reduced accordingly.

One of the features of the balanced-input circuit is the differential action of the amplifier. This circuit makes it possible to reject to a considerable degree any common-mode signal, while at the same time passing and amplifying the balanced-input signal. Thus, if there is any pickup of noise on test leads or in the equipment under test, such noise will be reduced materially on passing through the balanced-input amplifier circuit. The maximum amplitude of such signals should not reach beyond $\pm$ 3V for optimum performance.

2-13. USE OF PROBES

An attenuator probe lessens both the capacitance and resistive loading caused by the oscilloscope to a minimum value. Simultaneously, while isolating the oscilloscope from the signal source, it reduces the effective sensitivity of the instrument. In other words, the displayed waveform will be reduced in amplitude by the attenuation factor of the probe. The attenuation introduced by the probe permits measurement of signal voltages in excess of those which may be accommodated by the instrument.

When using a probe to sample signals from a tuned, matched, or otherwise critical circuit, capacitive loading may cause erroneous readings. In these cases it may be necessary to add capacity and resistance to the circuit under observation of a value precisely equal to that of the probe impedance after the probe is removed from the circuit. This substitution will equalize loading and restore the measured characteristics of the circuit under observation.

When using the attenuator probe to make amplitude measurements, multiply the observed amplitude of the display by the attenuation factor marked on the probe.

The Du Mont Type 4290 accessory probe for the Type 401-B units, has an attenuation factor of 10 to 1. The maximum voltage that may be applied to the probe is 600 volts peak-to-peak. Voltages in excess of this value (either dc volts or peak ac volts) may cause damage to components inside of the probe housing.

IMPORTANT: Before using the probe, always check its adjustment.

An adjustable capacitor in the probe body compensates for variations in input capacitances from one unit to another. To insure accuracy in pulse and transient measurements, check the probe adjustment frequently. To check the probe, set the TRIG LEVEL control to PRESET, the TIME/CM control to 500 μs/cm, and the X

VOLTS/CM switch to AUTO. Apply the probe tip to the GATE OUT connector. Adjust the probe capacitor for a flat trace on the screen.

To preserve the waveform of the signal being displayed, clip the probe ground lead to the chassis of the equipment being tested. Select a short clean ground point near the probe input connection.

2-14. OPERATING HINTS FOR THE SWEEP CHANNEL

a. Automatic Sweep

In some applications, it is desirable to have the sweep free-running, whether synchronized or not. When using the AUTO mode, a horizontal reference trace will appear on the screen, even in the absence of an input signal. This AUTOmatic mode is very useful while testing equipment since a reference trace will always be visible during the time no signal is applied to the oscilloscope. The AUTO mode simplifies synchronization of signals having repetition rates greater than 50 cycles and is useful while observing periodic waveforms.

To obtain AUTOmatic sweep operation, set controls as outlined under paragraph entitled "Driven Sweep", except turn X VOLTS/CM switch to AUTO position.

b. Driven Sweep

A stable pattern for practically all types of signals can be obtained by using driven sweep. Its use is mandatory for viewing random or nonperiodic signals of low-duty cycle. When operating the instrument in this manner, one sweep occurs for each single impulse. Use of the driven sweep mode of operation in the majority of applications, is the condition under which optimum performance can be expected of this equipment.

When the oscilloscope is set for DRIVen Sweep, the spot will be visible only during forward sweep time. The INTENSITY control must be properly adjusted to make the sweep visible. Intensity should not be set so bright as to override the retrace blanking. For driven sweep operation, follow the procedure outlined below.

1. Set front-panel controls as follows:

CONTROL	POSITION
X VOLTS/CM	DRIVen Sweep
Y VOLTS/CM	Set as determined by amplitude of signal source or at 0.01
VERNIERS (all three)	CAL
TRIGGER SOURCE	+ INT

2. Apply desired signal to Y INPUT.
3. Adjust TRIG LEVEL control to initiate the sweep and the POSITION controls to center the pattern.
4. Adjust Y VERNIER control in conjunction with Y VOLTS/CM switch to obtain a vertical deflection of approximately 5 centimeters.
5. Adjust X VERNIER control to expand the trace. If display tends to move off screen, adjust the X BAL control to position it back on screen.
6. Rotate the TIME/CM and VERNIER controls to obtain the desired number of cycles. Readjust TRIG LEVEL control if necessary.
7. Adjust INTENSITY and FOCUS controls to obtain a sharp trace of suitable brightness.
8. If there is any multiple triggering of the sweep, the TRIG LEVEL control may be adjusted to select the signal levels which will best actuate the trigger circuit. Thus, undesirable signals of lesser amplitude will not affect the sweep.

c. Single-Sweep Operation

In a majority of applications, a repetitive sweep is used. However, when it is desired to view a single display which continually varies in amplitude, shape, and time, the X VOLTS/CM switch should be set to SINGLE, for single-sweep presentation. Single-sweep operation infers that the time base moves but one stroke until reset. Reset may be accomplished by setting the X VOLTS/CM switch to RESET, or through external contact closures.

Using a repetitive sweep to view a varying waveform would result in an overlapped and unintelligible display caused by many cycles of the

single trace being superimposed on one another. Simply turning the X VOLTS/CM switch to the SINGLE position, eliminates the overlapping caused by the multiple traces and enables the display to be viewed and/or recorded clearly.

1. INTERNAL RESET
   A single trace will sweep across the screen each time the sweep is triggered. At the end of its travel, the beam will rest off screen, and the right beam position indicator, with RESET lettered beneath it, will light indicating that the sweep requires rearming (resetting). To rearm the sweep, turn X VOLTS/CM switch from SINGLE to RESET and back to SINGLE position. The indicator light will go out indicating the sweep is armed and ready to fire on the next trigger.

2. EXTERNAL RESET
   The sweep may be armed remotely by means of a contact closure introduced through the two-contact socket located on the rear of the instrument. See Figure 2-15.

   The Du Mont Type 4001 Sweep Rearming Kit is available as an accessory for remote rearming of the sweep. All the necessary parts and complete instructions for installation and operation will be supplied with the kit.

d. Sweep Expansion (Uncalibrated)

When the X VERNIER control is set fully clockwise but with its switch *not* actuated, sweep expansion about the center of the sweep up to a ratio of 5:1 (uncalibrated) may be obtained. Under this condition, using the X POSITION control enables any portion of the expanded sweep to be displayed on the screen.

e. Sweep Expansion (Calibrated)

1. To calibrate expanded sweep, proceed as follows:

   Set the following controls to position indicated:

CONTROL	POSITION
Y VOLTS/CM	CAL
X VOLTS/CM	AUTO
X VERNIER	CAL
TIME/CM	10 MS/CM
TRIGGER SOURCE	+ INT
TRIG LEVEL	PRESET

2. Adjust TIME/CM VERNIER control to obtain a display of 10 cycles full scale of the calibrated waveform.
3. Adjust X VERNIER control to obtain a display of only 2 cycles full scale. The Sweep Expansion is now 5:1.
4. Changes in sweep time and sweep vernier settings and changes in mode of sweep operation (Driven, Auto, Single) will not effect the calibration. Care must be exercised not to accidentally move the X VERNIER control from the previous setting.

f. Obtaining Lower Sweep Writing Rates

Obtaining lower sweep wirting rates than are provided for in the instrument is accomplished by using external sweep capacitors.

The lowest sweep rate available in this instrument without using external sweep capacitors is 10 seconds full scale or 1 second/cm with the TIME/CM switch set to 200 and the TIME/CM VERNIER control set fully clockwise. To make connections for lower sweep rates, proceed as follows:

CAUTION

THE EXT SWP CAP TERMINALS ARE 150 to 250 VOLTS ABOVE GROUND

1. Turn power off.
2. Remove cover on rear of unit to gain access to EXT SWP CAP terminals.
3. Connect external capacitor.
4. Replace cover.

The sweep rate will be reduced by 2:1, that is, from 1 second/cm to 2 seconds/cm by addition of a 0.12 μf 200-volt capacitor. Refer to Figure 2-14 to determine other values of external capacitance and sweep rate.

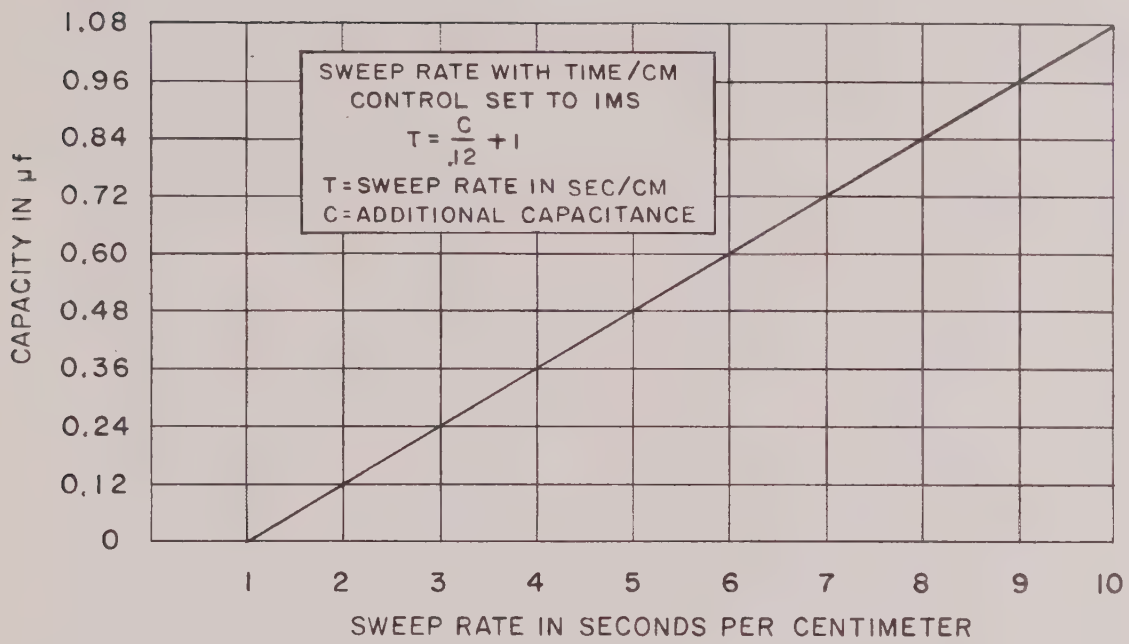


Figure 2-14. Additional Capacitance Versus Sweep Rate

The addition of the external sweep capacitance will affect the sweep rate for the 6 longest positions of the TIME/CM switch, extending each range by the factor: $\frac{C}{0.12} + 1$ (See Figure 2-14).

A high-leakage-resistance capacitor of the best quality is recommended. Ordinary paper capacitors have high temperature coefficients and poor recovery characteristics. The results obtained in extending the sweep range will depend entirely on the quality of the external capacitor.

g. Reduction of Expanded Sweep to Zero

In order to reduce sweep amplitude to zero when the VERNIER control is set fully counterclockwise, the following modification should be made.

Short out resistor R1214, located on the X VERNIER control R1215.

When this modification has been performed, care must be exercised to avoid overloading the X amplifier when being used for X-Y plotting.

2-15. REAR-PANEL FACILITIES

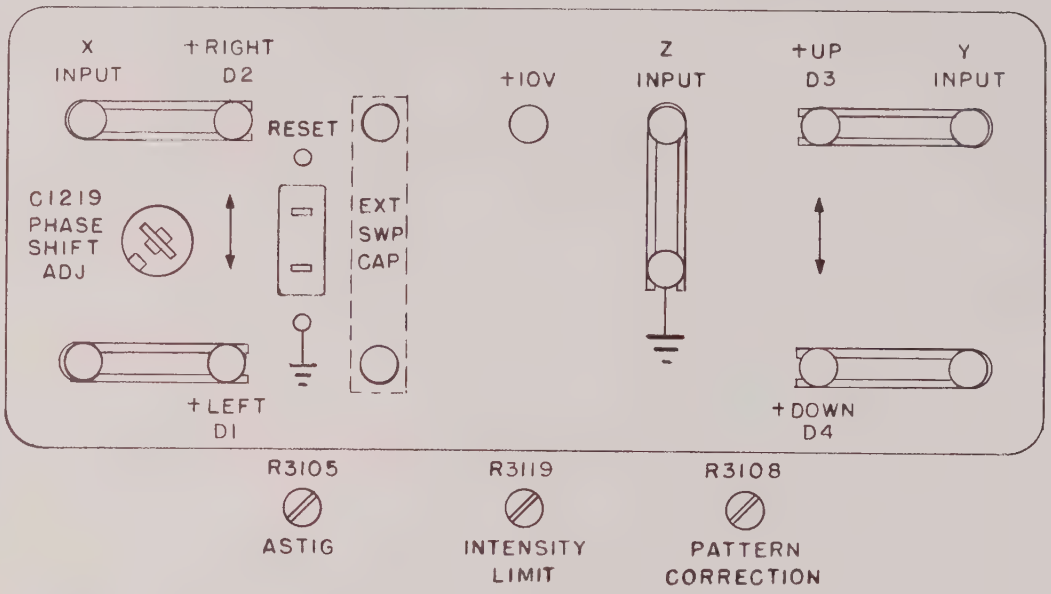
With one exception, the rear-panel facilities on both the Types 401-B and 401-BR are identical. In the 401-BR rack model, the front panel binding posts are duplicated in the rear of the instrument. Two slide switches are provided on the front panel of the rack-mounted version, one in the X and one in the Y circuit. When positioned to the left, the front binding posts are connected to the specific amplifier and the rear terminals are out of the circuit. When positioned to the right, the rear binding posts are connected to the specific amplifier and the front terminals are out of the circuit.

Adjustment procedure for ASTIG, INTENSITY LIMIT, and PATTERN CORRECTION controls is explained in Section 4 of this manual.

2-16. DEFLECTION PLATE CONNECTIONS

a. General

When applying signals to deflection plates, the highest frequency signal that can be observed is not limited by the response of the built-in amplifiers, but is dependent upon the input capacitance to the deflection plate terminals and/or transit time of the electrons between the deflection plates. Provided the impedance of the signal source is kept low, transit time is the only consideration. It should be remembered however, that no amplification or attenuation is provided on direct input. See Table 1-1 for deflection sensitivities.



NAME	FUNCTION
EXT SWP CAP	Provides connection for external sweep capacitor when TIME/CM switch is set to its 6 slowest sweep rate settings. These terminals are at + 150 to + 250 volts.
X INPUT	Terminals D1 (left) and D2 (right) provide direct connection of signals to the horizontal deflection plates with jumpers removed. The two terminals on extreme left are the output of the horizontal amplifier and are connected by jumpers to the horizontal deflection plate terminals D1 and D2. These terminals are at a + 245V dc level.
Y INPUT	Terminals D3 (UP) and D4 (DOWN) provide direct connection of signals to the vertical deflection plates with jumpers removed. The two terminals on extreme right are the output of the vertical amplifier and are connected by jumpers to the vertical deflection plate terminals D3 and D4. These terminals are at a + 245V dc level.
Z INPUT	Provides connection for external signals for intensity modulation of the trace.
PHASE SHIFT CAP	Provides adjustment for zero phase differential between the X and Y amplifiers.
+ 10V	Screw terminal providing a high impedance dc voltage to facilitate triggering from external contact closures.
ASTIG	Provides voltage adjustment for the cathode-ray tube to optimize spot shape.
INTENSITY LIMIT	Adjusted to limit brightness level with main Intensity control.
PATTERN CORRECTION	Adjused to minimize pattern distortion.
RESET	Du Mont Accessory Type 4001. Supplied as kit to enable sweep to be armed remotely by means of a contact closure introduced through the two-contact socket.

Figure 2-15. Function of Rear-Panel Facilities

b. Direct Deflection Plate Connections

CAUTION
BEFORE MAKING CONNECTIONS, TURN POWER OFF

Direct connection to the deflection plates is made by removing links on deflection plate terminals. See Figure 2-15, and note the following:

1. External deflection plate return resistors must be provided, when using AC coupling and internal positioning.
   Single-ended input, 5 megohms (maximum) either plate to ground; balanced input, 10 megohms (maximum) center-tapped to ground.

2. When using DC coupling, the average dc potential of approximately 245 volts above ground should be preserved on both pairs of deflection plates for best focus; however, the astigmatism adjustment (R3105) has sufficient range for potentials from 200 to 300 volts.

3. This average dc level should be made adjustable to provide an astigmatism control for optimum focus adjustment.

4. A loss of positioning will occur. To retain front-panel control of positioning, follow steps outlined in next paragraph.

c. Obtaining Positioning Voltage

Removing the links when making direct connections to the deflection plates also removes the positioning voltage, making the front panel position controls inoperative. To retain front panel control of positioning, follow the steps as outlined and refer to Figures 2-15 and 2-16.

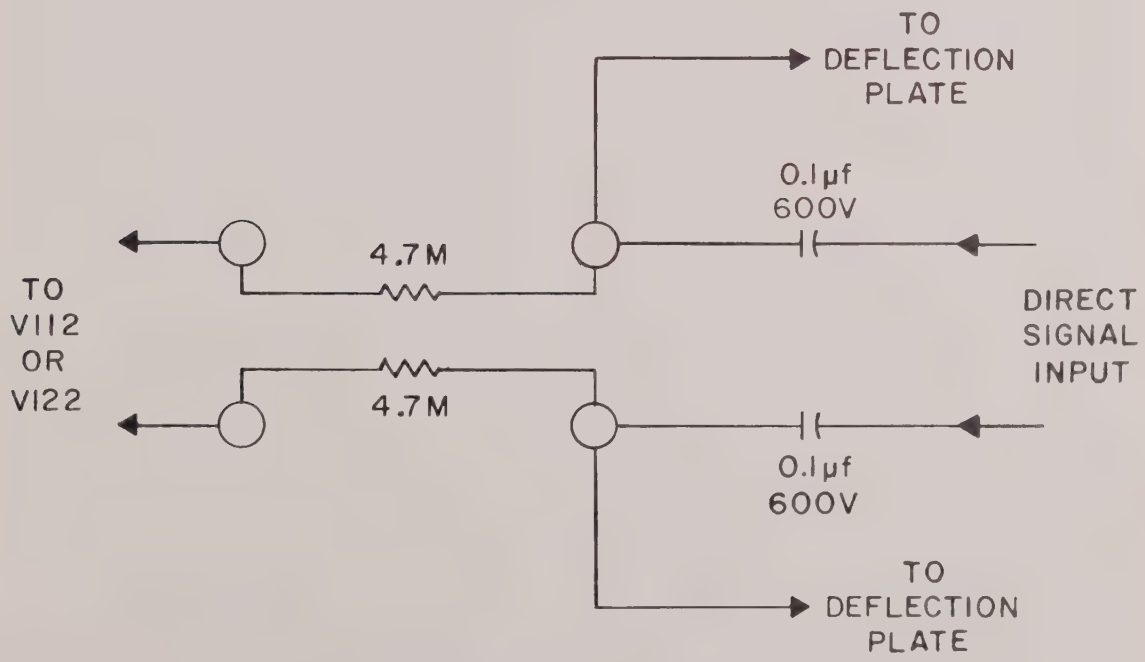


Figure 2-16. Circuit for Retaining Front Panel Control of Beam Position when Using Direct Signal Input

1. Disconnect the appropriate CRT deflection-plate links from their terminals.
2. Remove links on Amplifier terminals and bridge each pair of terminals with a series resistor (4.7 megohms) in each leg.
3. Connect the signal through blocking capacitors of at least 600 volts dc rating.
4. To avoid any possibility of cross-coupling effects, it is suggested that when connecting a signal direct to deflection plates, the corresponding channel (X VOLTS/CM and/or Y VOLTS/CM) controls be switched to OFF.

2-17. INTENSITY (Z AXIS) MODULATION

Positive signals applied to Z INPUT will decrease the beam intensity. To make connection for intensity modulation of the trace, turn power off, remove link and apply intensity modulation signal to the Z INPUT. Connection to the Z INPUT applies the signal between the CRT cathode and ground. A positive signal of 15 volts will cause sufficient blanking. The Z INPUT presents an impedance of 10,000 ohms and 30 pf ($\mu\mu$f) to the signal source, coupled through a 0.01 capacitor.

Always reconnect the link between the Z INPUT terminals when not using external intensity modulation.

2-18. VOLTAGE MEASUREMENTS

a. General

The Du Mont Types 401-B and 401-BR Oscilloscopes may be used to measure the voltage of the input signal by using the calibrated VOLTS/CM setting and observing the height of the display on the screen in centimeters.

When making voltage measurements, the operator should try to set up the instrument for full scale vertical deflection to insure maximum accuracy. Also, it is important to remember that the width of the trace may be an appreciable part of the over-all measurement. This is particularly true when you are measuring signals of small amplitude or when stray signal pickup has broadened the trace. The operator should consistently make all measurements from one side of the trace. If the top side of the trace is used for one reading, it should be used for all succeeding readings.

b. How to Measure Peak-To-Peak Voltages Using the CRT Scale

The procedure employed for all voltage measurements is basically the same. The Y VERNIER control must be switched to CAL. The specific examples that follow are intended to show the general procedure. These examples may be adapted to fit any particular application.

To measure the ac component of the signal on display, set the Y INPUT (AC/DC) switch to AC. In this position, only the ac components of the input signal are displayed on the screen. However, when the ac component of the input is of very low frequency (under 10 cps), set the Y INPUT (AC/DC) switch to DC to prevent errors. To make measurements, proceed as follows:

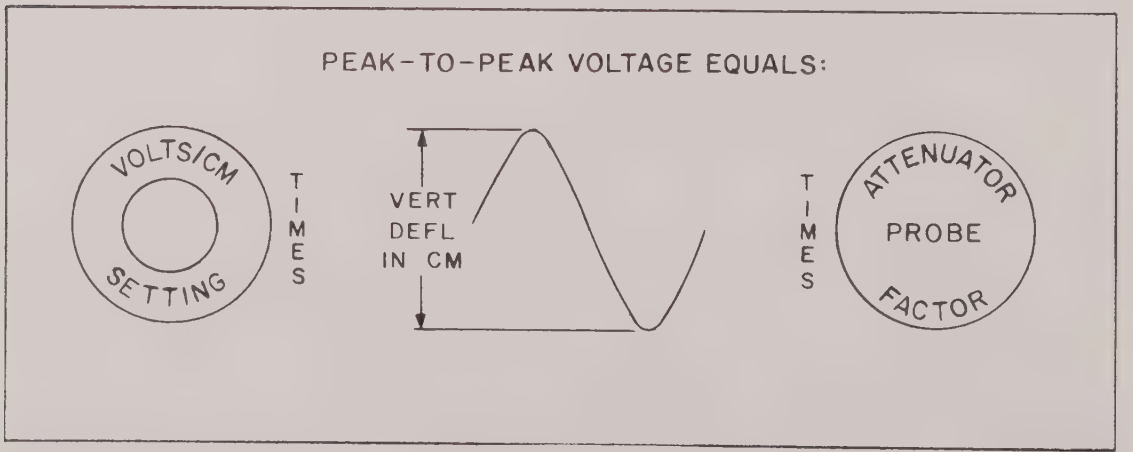


Figure 2-17. Peak-to-Peak Voltage Measurement

1. Using the calibrated scale, measure the vertical deflection in centimeters from the positive peak to the negative peak of the waveform. See Figure 2-17.
2. Multiply the vertical dimension obtained in Step 1 by the VOLTS/CM control setting to obtain the indicated voltage.
3. Multiply the indicated voltage obtained in Step 2 by the attenuation factor of the probe, if one is used, to obtain the actual peak-to-peak voltage.

For example, suppose that you are using a 10:1 attenuator probe and the VOLTS/CM control is set to 0.1. Assume that the vertical distance between the peaks of the waveform measures 4 centimeters. Now, the vertical dimension of 4 centimeters is multiplied by the VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation ratio of the probe. This gives 4 volts as the peak-to-peak voltage of the display waveform.

c. How to Measure Instantaneous Voltages With Respect to Ground (or Some Other Reference Potential) Using the CRT Scale

The technique used for measuring instantaneous voltages with respect to a reference point, is virtually the same as that described for peak-to-peak voltage measurements. The difference is that now a reference point must be established on the screen of the oscilloscope. Since voltage measurements with respect to ground are the most common, the procedure which follows, establishes ground as the reference point. The same general technique may be used for instantaneous measurements with respect to any other potential, just so long as that potential is employed to establish the reference point.

To make measurements, proceed as follows:

1. Set the Y INPUT (AC/DC) switch to DC.
2. Set the TRIG LEVEL control to PRESET.
3. To establish the reference point, touch the probe tip to the ground on the oscilloscope (or to the desired source potential) if a point other than ground is used).
   Vertically position the trace to a convenient point on the screen. This point should be chosen so that it lies on one of the major horizontal scale divisions. The chosen horizontal scale line, which is now coincident with the trace, is the reference line from which all voltage measurements are to be made.
4. Disconnect the probe tip from ground and connect it to the signal source without disturbing the POSITION control.
5. Adjust the oscilloscope controls for a suitable and stable display.

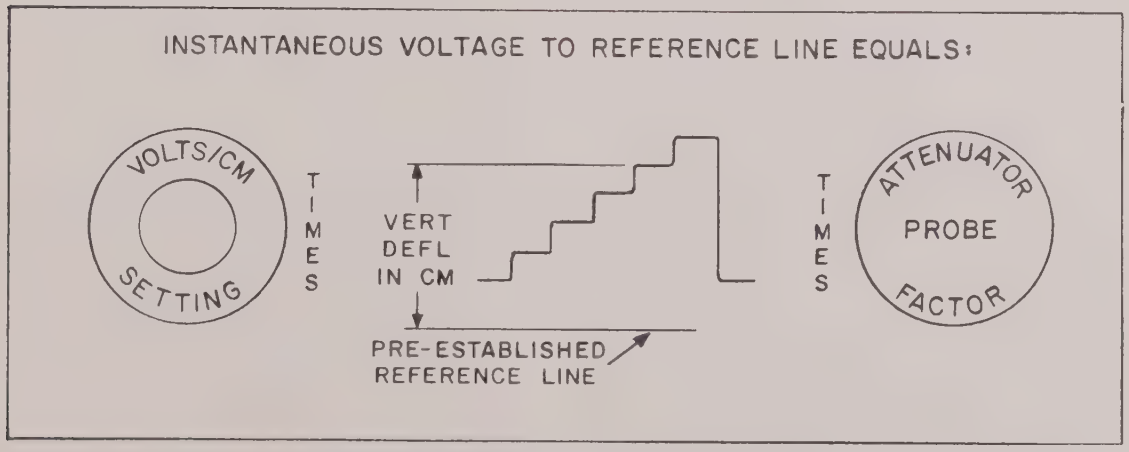


Figure 2-18. Instantaneous Voltage Measurement with Respect to Ground (or Some Other Reference Potential)

6. Using the calibrated scale, measure the vertical deflection in centimeters from the desired point on the waveform to the pre-established reference line set up in Step 3. See Figure 2-18.

7. Multiply the vertical dimension obtained in Step 6 by the VOLTS/CM control setting to obtain the indicated voltage.

8. Multiply the indicated voltage obtained in Step 7 by the attenuation factor of the probe used to obtain the actual instantaneous voltage.

For example, suppose that you are using a 10:1 attenuator probe and the VOLTS/CM control is set to 0.1. Assume that the vertical distance between the desired point on the waveform to the pre-established reference line is 4 centimeters. Now, multiply this vertical deflection of 4 centimeters by the VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation factor of the probe. This shows that the instantaneous voltage with respect to ground to be 4 volts. Since the voltage point is above the reference line, the indicated polarity is positive.

2-19. TIME MEASUREMENTS

a. How to Make Elapsed Time Measurements Using the CRT Scale

Any horizontal distance on the screen of the oscilloscope can be used to represent a precise interval of time, when the time-base circuits are set up for calibrated sweep (Time Vernier in Cal position). Use of this feature permits you to accurately measure the elapsed time between the desired point of interest on the display. To measure the time interval, proceed as follows:

1. Using the calibrated scale, measure the horizontal distance in centimeters between that portion of the display whose time interval you wish to find.

2. Multiply the horizontal dimension obtained in Step 1 by the TIME/CM control setting to obtain the time interval. See Figure 2-19.

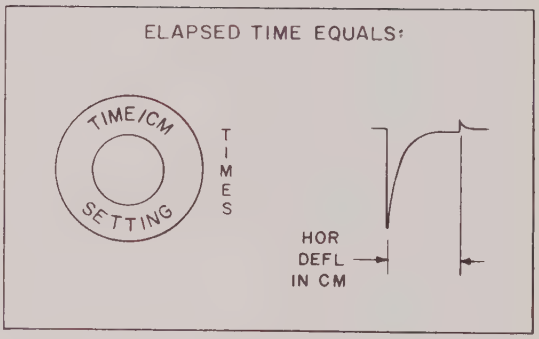


Figure 2-19. Elapsed Time Measurement

b. How to Find Repetition Rate or Frequency Using the CRT Scale.

The repetition rate or frequency for periodic signals can be expressed as the number of cycles or pulses per unit of time. To use the oscilloscope for measuring the repetition rate or frequency of periodic signals, proceed as follows:

1. Using the calibrated scale, measure the horizontal distance in centimeters occupied by one cycle of the display under observation.

2. Multiply the horizontal dimension obtained in Step 1 by the TIME/CM control setting.

3. Take the reciprocal of the product obtained in Step 2 (that is, divide it into one). The resulting quotient is the desired frequency or repetition rate in cycles per second. See Figure 2-20.

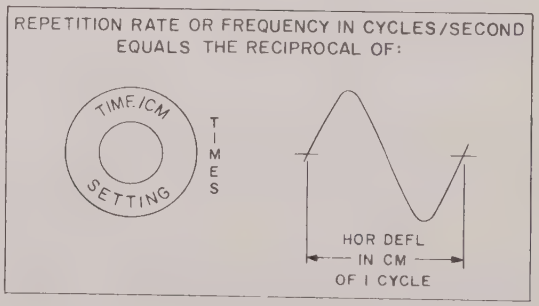


Figure 2-20. Finding the Frequency

2-20. RISE-TIME MEASUREMENTS

Application of signals from an external time calibrator will facilitate pulse rise-time measurements. When making such measurements, the one factor which must be borne in mind for most accurate quantitative results is the pulse response characteristic of the vertical amplifier. This characteristic is related to the observed pulse rise time and the actual pulse rise time in the following manner:

$$t_p = \sqrt{(t_o)^2 - (t_a)^2}$$

Where: t_p = actual pulse time in microseconds

t_o = observed rise time of pulse in microseconds

t_a = amplifier rise time in microseconds

Once the amplifier rise time is known (see Table 1-1), the rise time of any pulse may be calculated.

To make rise-time measurements, proceed as follows:

1. Adjust pattern for full scale (10 cm) of vertical deflection.
2. Using the X and Y POSITION controls, adjust the display vertically so that the start of the waveform rests 1 centimeter below the scale horizontal center line and the rising portion of the waveform intersects the zero point on the scale (labeled A in Figure 2-21). Observe that the top of waveform is off screen. Be careful not to accidentally change the setting of the X POSITION control.
3. With the Y POSITION control, move the waveform down until the top portion of the waveform rests 1 centimeter above the horizontal center line.
4. Note where the rising portion of the waveform intersects the X axis (labeled B in Figure 2-21).
5. Measure the distance between points A and B; multiply this reading by the TIME/CM switch setting to obtain rise time.
6. For example, if the distance between points A and B is 3 centimeters and the TIME/CM switch is set to 5 μs, the rise time would be 15 μs.
7. Rise-time measurements made in this manner eliminate errors which would result from improper deflection plate alignment and incorrect interpolation.

Figure 2-21. Rise-Time Measurement

2-21. PHASE SHIFT MEASUREMENTS

Phase measurements are usually made when the frequencies of the two input ac signals are equal. Hence Lissajous figures that result from a phase difference between two input signals of the same frequency are often referred to as phase difference patterns. When the frequencies of the two input signals are not a 1:1 ratio, the Lissajous figures are generally used for frequency measurements.

To check the relative phase shift, proceed as follows:

1. Apply a sine wave signal to both the X and Y INPUT.
2. Center the trace horizontally and adjust the Y controls for 10 centimeters of vertical deflection. The pattern obtained should be similar to Figure 2-22.
3. The angle between the two signals is that angle whose sine is the ratio of A/B.

   Note: To obtain full scale vertical deflection of 10 centimeters, it may be necessary to temporarily reduce the horizontal amplitude of the display. To accomplish this, set the X VOLTS/CM switch one step counterclockwise from its initial setting. Adjust the display for 10 centimeters of vertical deflection. Reset X VOLTS/CM switch to its original setting, recenter the display and read dimension A in Figure 2-22.

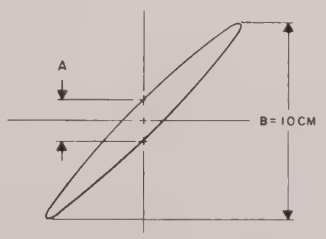


Figure 2-22. Phase Shift Measurement

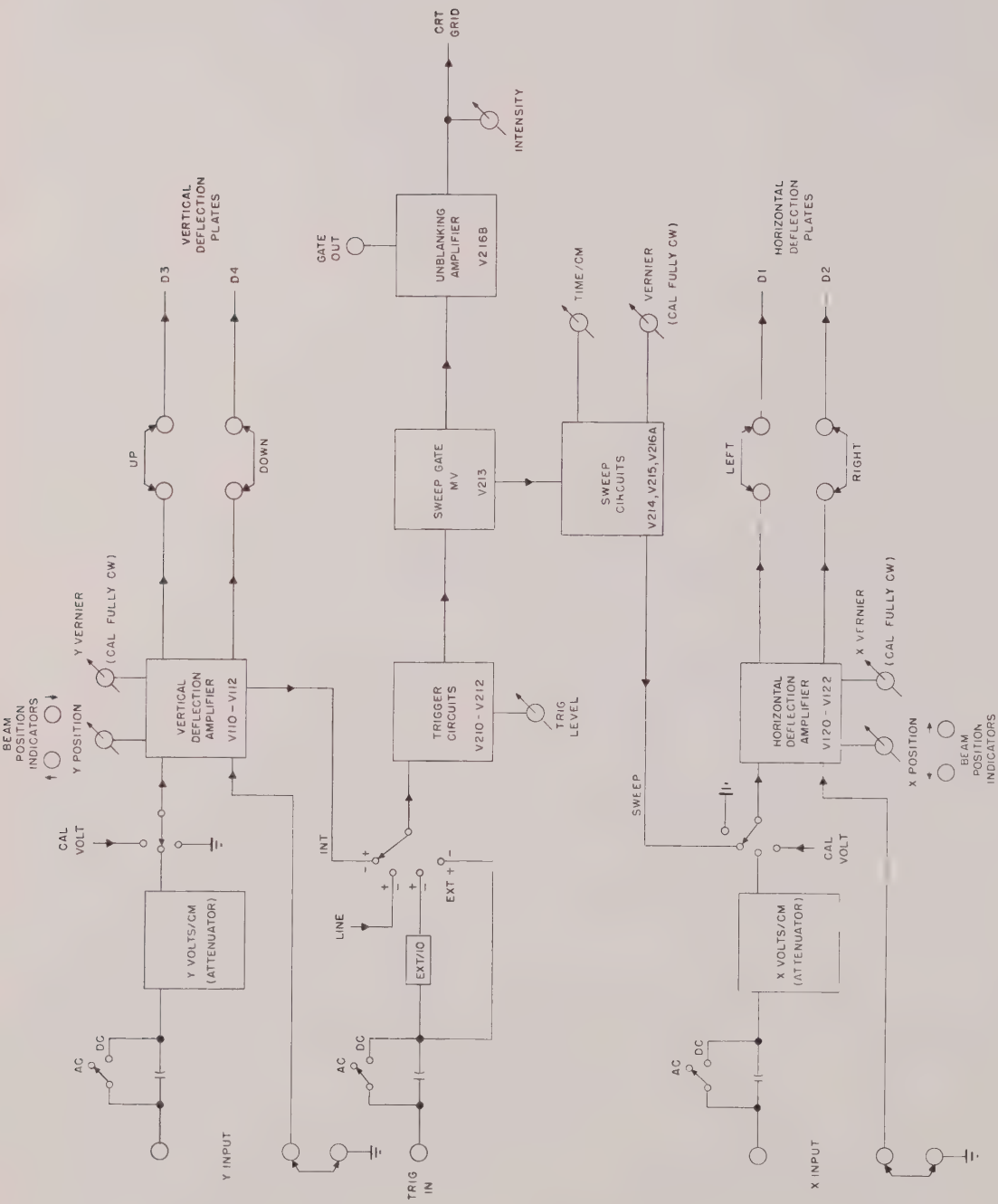


Figure 3-1. Du Mont Type 401-B/401-BR Oscilloscope, Simplified Block Diagram

SECTION III
CIRCUIT DESCRIPTION

3-1. GENERAL (Figure 3-1)

To simplify circuit analysis, the instrument can be divided into five basic sections as follows: (1) Vertical Deflection System; (2) Horizontal Deflection System; (3) Sync Circuit; (4) Sweep Circuit; and (5) Regulated LV and HV Power Supplies. The circuit description will be keyed to the functional block diagram, Figure 3-1. Emphasis is placed on the inter-relation of circuits rather than on detail of operation. It is also recommended that the Schematics at the rear of this Manual be referred to in following the circuit description.

3-2. VERTICAL DEFLECTION SYSTEM

a. Input Circuit

The Y VOLTS/CM switch selects the desired attenuation of the input signal in decade steps from 0.01 volt to 10 volts/centimeter. The OFF position of this switch removes the input signal from the attenuator and grounds the grid of the input dc amplifier V110.

The AC/DC switch inserts a blocking capacitor in series with the Y INPUT connector in the AC position and removes it in the DC position.

The front panel input terminals are duplicated at the rear of the rack-mounted unit. Front/rear switching is possible on the front panel to allow choice of either front or rear connection.

The input decade attenuators are RC compensated to maintain frequency and phase response and to present an impedance of 1.0 megohms in shunt with 47 pf ($\mu\mu$f) nominal to the circuit under test, regardless of the attenuation selected.

Provision is made for applying a balanced signal to Y INPUT when the Y VOLTS/CM switch is set to the DC 0.01 Volt/cm position. For details on use of this feature, refer to Section 2, Operation.

b. DC Amplifier Operation

The vertical deflection dc amplifiers comprise V110 through V112 inclusive. Regulated dc heater voltage is supplied for the first two stages. The dc balanced circuit arrangement provides

good deflection amplifier stability. The input dc amplifier, V101 (which on balanced inputs, acts effectively as a differential amplifier) precedes the continuously variable Y VERNIER control R1115.

The normally grounded grid of V110B is brought out to the front-panel binding post, J1102, so that balanced input operation may be obtained simply by removing the ground link between J1102 and J1103. The RC Networks R1107 and C1109; and R1108 and C1111, in series with the grids of V110 serve to protect the input circuit from damage due to excessive input voltage. The shunt capacitors preserve the high-frequency signal components.

The Y BAL front-panel screwdriver control, R1111, equalizes the voltages at the ends of the Y VERNIER control. When this control is properly set, there will be no shifting (up and down) of the trace when Y VERNIER control is rotated throughout its range with no signal applied to the amplifier. When the Y VERNIER control, R1115, is switched fully clockwise, the amplifier is set for calibrated operation. The Y CAL front-panel screwdriver control, R1117, is used for normalizing the gain of the vertical deflection amplifier.

The Y DP LEVEL ADJ, R1121, is provided to set the deflection plate voltage of the cathode-ray tube so that the output of the internal trigger divider is at ground when the beam is centered.

For amplitude measurements, an internal calibrating voltage is applied to the vertical input dc amplifier, V101B, when the VOLTS/CM switch is set to CAL. This switch automatically disconnects the Y INPUT signal from the amplifier when the calibrator signal is applied. The output of V112 is applied to the vertical deflection plates. Two neon lamps, DS1101 and DS1102, are connected across the vertical deflection plates and biased slightly below these plates. These lamps indicate which direction the spot is off the screen if it cannot be seen. If either plate assumes a voltage much higher than the average voltage, the beam position indicator connected to that plate will be lit.

3-3. HORIZONTAL DEFLECTION AMPLIFIER

Since identical vertical and horizontal amplifiers are employed in the Types 401-B and 401-BR, the previously discussed theory for the vertical amplifier is equally applicable, except for the X VOLTS/CM switch. By means of the X VOLTS/CM switch, provision is made for the selection of internal or external signals for horizontal deflection. The internal signal is obtained from the sweep circuits described elsewhere in this Section. External signals may be applied to the X INPUT terminals. The X DP LEVEL ADJ is used to set the X deflection plate average potential equal to the Y DP average potential.

A phase shift trimmer, C1219, is added across the output of the horizontal deflection amplifier, V122, so that zero phase differential (between the X and Y amplifiers) may be obtained at the upper frequency limits specified. Provision is made for direct input to both the vertical and horizontal deflection plates. See Paragraph 2-16 for use of this feature.

3-4. TRIGGER CIRCUIT

a. Trigger Amplifier and Level Selector

The TRIGGER SOURCE switch selects the source of the triggering voltage and arranges the trigger amplifier input, V210, to trigger on the negative-going or positive-going portion of the triggering signal.

The trigger amplifier, V210, is a cathode-coupled amplifier. By means of the TRIG IN switch S211, capacitor C2104 can be switched into the grid circuit to remove the dc component of the trigger signal. Output is always taken from the A-Section plate, but the TRIGGER SOURCE switch S210, connects either the A-Section grid or the B-Section grid to the input trigger source. The latter action permits trigger polarity selection.

For positive-going signals, connection is made to the grid of V210A, and for negative-going signals, connection is made to the grid of V210B. In each case, the opposite grid is connected to a dc bias source, adjustable by means of the TRIG LEVEL control R2106.

The TRIG LEVEL control is used to select the level of the triggering point for all settings of the TRIGGER SOURCE switch. A PRESET position is provided on the TRIG LEVEL control to simplify operation and to optimize trigger channel sensitivity.

The TRIG LEVEL CENT adjustment, R2113, sets the level of V210 so that no readjustment of the TRIG LEVEL control is required when the TRIGGER SOURCE switch is set from plus to minus slopes or vice versa. This adjustment is made with the TRIG LEVEL control in the PRESET position.

b. Schmitt Trigger Generator

The Schmitt Trigger Generator is essentially a regenerative signal amplitude selector. It consists of a two-stage amplifier, V211A and V211B, having dc plate-to-grid coupling from A to B amplifier and dc cathode-to-cathode coupling. The circuit has two stable states: the A side conducting, the B side at cutoff; the B side conducting, the A side at cutoff. The transition from one state to the other is abrupt, producing fast rise and fall times from each side of the circuit.

The dc voltage applied to the grid of V211A determines which state the circuit will be in. Assume operation as follows: V211A is conducting and V211B is at cutoff. V211B will remain at cutoff until the amplitude of a positive-going signal applied to its grid, reaches the threshold level of conduction. When this threshold level is exceeded, an abrupt transition from cutoff to full conduction will occur in V211B. Simultaneously, V211A will promptly stop conducting. V211A and V211B will revert to their original condition when the amplitude of the initiation signal falls slightly below the threshold level of conduction for V211B.

In general, the threshold voltage is higher when moving the grid in a positive direction, and lower when moving the grid in the negative direction. The two different voltage levels are called the upper and lower hysteresis limits of the Schmitt Trigger Generator.

The initial A-side grid level can be positioned anywhere inside or outside of the hysteresis area, thus establishing the input voltage required to change the state of V211A. The steady state grid bias of V211A is normally determined by the TRIG LEVEL control setting.

When the X VOLTS/CM switch is set to AUTO, the trigger amplifier is ac coupled to the input grid of the Schmitt Trigger Generator through C2108 and the feedback resistor R2126, is connected between the grids of the Schmitt Trigger Generator. This causes V211A and V211B to flip back and forth, yielding about 50 pulses per second. Thus, a horizontal reference trace will appear on the screen even in the absence of an input signal.

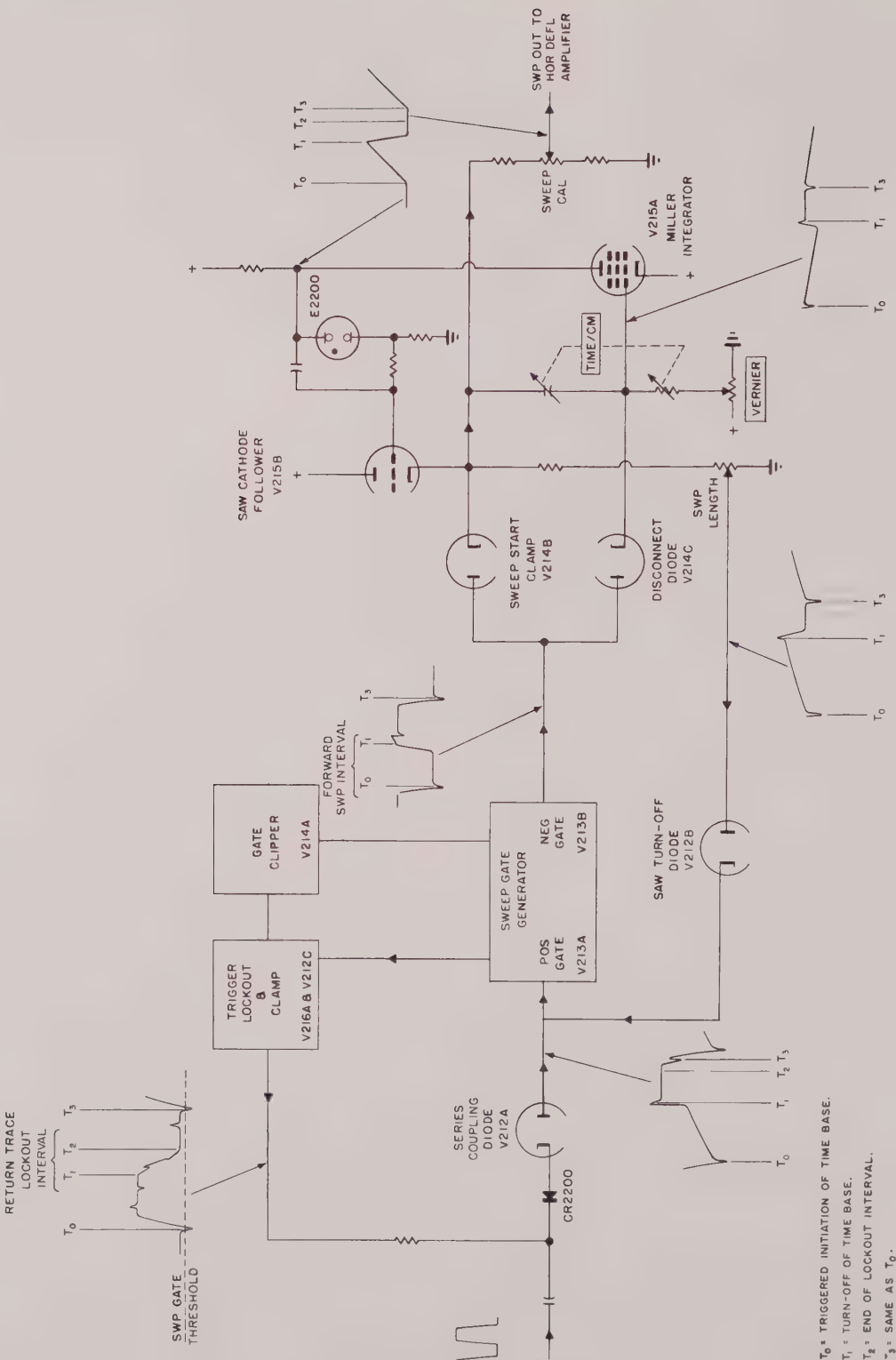


Figure 3-2. Sweep Generator, Simplified Diagram

3-5. SWEEP CIRCUIT (FIGURE 3-2)

a. Sweep Gate Generator

The dc coupled bistable multivibrator, V213A and V213B, initiates the formation of the sweep upon receipt of a negative trigger from the Schmitt Generator at time T_0, and holds off subsequent triggering signals until after the sweep is completed. In the quiescent state, V213A is conducting and V213B is at cutoff. V213A forms a positive gate while V213B forms a negative gate during the forward sweep interval. CR2200 serves as a low-capacitance coupling diode and V212A serves as a high back-impedance diode to couple only negative triggers from the Schmitt Generator to initiate the sweep. After the bistable multivibrator has been triggered, it will revert to its original state at time T_1, by means of a portion of the positive saw supplied from the sweep circuit.

b. Sawtooth Generator

The sawtooth generator is a Miller integrator circuit. The circuit includes the sweep start clamp V214B, the disconnect diode V214C, the Miller integrator V215A, the saw cathode follower V215B, and the RC timing networks mounted on the TIME/CM switch S220. The grid of the saw cathode follower V215B, is connected to the plate of the Miller integrator, V215A, through a neon glow tube E2200. The grid of V215B therefore follows the plate changes of V215A but remains at a fixed negative voltage with respect to the plate.

C2204 and R2237 is a network around E2200 to improve rise time and to suppress parasitic oscillations. At time T_0, the negative step from the sweep gate generator, V213B, to the plate of the disconnect diode, V214C, lowers the plate voltage below the cathode, and this diode no longer conducts.

Consequently, the Miller integrator grid and the plate with its dc coupled saw cathode follower are thus released to seek their own voltage levels.

When the grid of the Miller integrator moves negatively, the plate voltage rises positively, carrying the saw cathode follower grid, cathode, and timing capacitor positively, which thus tends to prevent the Miller integrator grid from going negative. Since the grid of this tube remains at a constant potential within a small fraction of a volt, the current through the TIME/CM charging resistor remains constant, and the sweep timing capacitor thus charges at a constant rate. The linear rise at the cathode of the saw cathode follower is subsequently employed as the internal time base signal.

The cathode of V215B continues to rise linearly until the positive step from the sweep gate generator V213B, at time T_1, returns the disconnect diode V214C back to its conducting state which raises the grid level of the Miller integrator V215A. When V215A grid rises, its plate voltage drops, carrying the saw cathode follower, V215B, with it until its cathode clamps again through V214B and V214C at the quiescent level. The sweep start clamp diode, V214B, holds the start of the sweep constant.

The positive-going transition from the sweep generator, V213B, occurs when a portion of the positive sawtooth is applied to the grid of V213A. This causes the multivibrator to revert to its original state, thereby terminating the sweep. This signal is fed back through the SWEEP LENGTH adjustment, R2222, and the saw turn-off diode V212B. When the voltage tapped off from the SWEEP LENGTH is properly set, the sweep will terminate at a time which corresponds to slightly more than 10 centimeters of deflection at the rate shown on the TIME/CM switch.

The trigger lockout and clamp circuits, V216A and V212C, are designed to hold off any trigger signals from initiating the sweep gate, during the time interval T_1 to T_2, until all capacitances in the circuit have had time to reach their quiescent voltage levels. At time T_3, the sweep gate threshold voltage level is exceeded by the initiating trigger, and the sweep cycle described above is repeated.

3-6. LOW-VOLTAGE POWER SUPPLY

a. Power Transformer

Plate and heater power for this instrument is provided by a single power transformer, T3200. The primary is wound with two equal 115-volt windings that can be connected either in parallel for 115-volt operation, or in series for 230-volt operation. The secondary contains two separate high-voltage windings and four separate heater windings.

b. Regulated Supplies

Three regulated positive supplies and one regulated negative supply are provided with outputs as follows: +390 volts, +150 volts, +85 volts, and −50 volts.

The +85-volt regulated output is provided by gas diode, V323, and is also the voltage reference source for the other low-voltage regulated supplies.

Operation of the other low-voltage regulated supplies is identical, so only the +390-volt supply is described. V321 is connected in a conventional full-wave rectifier circuit. The rectified output is capacitively filtered by C3211 and C3212. Three capacitors are shunted by resistors R3221 and R3222 to equalize the voltage across them.

The filtered rectified output is applied to V324A, a series passing tube whose series resistance is adjusted by the sample fed back from R3234F through the dc amplifier V322A to its control grid. If the +390-volt output changes due either to a change in input voltage or load current, the sample voltage changes and alters the passing tube grid to return the output to +390 volts.

c. Voltage Calibrator

The power-line frequency voltage from T3200 is applied to the voltage calibrator, V320, through limiting resistor R3200. With the plate of V320A tied to ground, any negative voltage impressed on this section will cause conduction, thus clamping the negative half-cycle at approximately ground potential. On the positive half cycle, conduction occurs in the other half section, V320B, when the peak applied potential exceeds +150 volts, thus clipping the sine wave at that point. The resulting trapezoidal waveform is applied to a voltage divider R3203, R3205, and C3200. The attenuated output is coupled to the vertical and/or horizontal amplifier when the appropriate VOLTS/CM switch is set to CAL.

3-7. HIGH-VOLTAGE POWER SUPPLY

Accelerating voltages for the cathode-ray tube are obtained by rectifying a 60 Kc high voltage produced by a vacuum-tube oscillator. V313 is the oscillator tube connected as a Hartley oscillator with the primary of transformer T3100 as the tapped inductor, and C3113 as the capacitor.

A conventional half-wave rectifier, V310, supplies the necessary voltage for the post-deflection accelerating anode of the cathode-ray tube. Operating potentials for the proper intensity and focusing of the cathode-ray tube are derived from the regulated supply. Regulation is accomplished by sampling a portion of the rectified output and applying a correction signal back through V314 to the screen grid of V313.

Two rectifiers, CR3101 and CR3102, furnish cathode and grid voltage for the CRT. The grid supply is made separate from the cathode supply so that unblanking pulses may be coupled to the control grid of the cathode-ray tube. The positive end of the control-grid supply is connected to the plate of the unblanking gate amplifier V216B through the INTENSITY control. The negative end is connected to the control grid of the cathode-ray tube. Thus, the entire grid supply follows the unblanking pulse from V216B, transmitting the pulse directly to the control grid of the cathode-ray tube. C3104 transmits the leading edge of the unblanking pulse to reduce unblanking time for fast sweeps.

SECTION IV
MAINTENANCE

4-1. INTRODUCTION

This section of the manual contains Service Information and Procedures for Internal Adjustments.

WARNING

OBSERVE THE FOLLOWING PRECAUTIONS WHEN NECESSARY TO ENERGIZE THE EQUIPMENT WITH THE PANELS REMOVED

1) Never work alone.
2) Make sure the chassis is properly grounded.
3) Disconnect power cord before changing any tubes.
4) Before touching any components, short the terminals to remove any possible charge that may remain after turning off the power.

4-2. PREVENTIVE MAINTENANCE

You should visually inspect the entire Oscilloscope every few months for possible circuit defects. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, or broken terminal strips. For most visual troubles the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of components is often the consequence of other, less obvious defects in the circuit. It is essential that you determine the cause of overheating before replacing heat-damaged components in order to prevent further damage. This Oscilloscope is a stable instrument that will provide many hours of trouble-free operation. However, to insure the reliability of measurements, we suggest that you recalibrate the instruments after each 500 hours of operation (or every six months if used intermittently). Complete recalibration procedures are given in this manual.

4-3. GAINING ACCESS TO CHASSIS

The panels of this instrument are held in place by screws. The bottom mounting holes on each side panel are slotted, eliminating the need for complete removal of screws. To remove panels, loosen the bottom screws and remove the four top screws; then pull the top portion of the panel outward and lift straight up. This will expose most of the tubes and all service adjustments for normal maintenance. To remove bottom panel, lay the instrument on its side, remove the four screws and pull off the panel. Panels are replaced by reversing the order of their removal.

4-4. CATHODE-RAY TUBE REPLACEMENT

CAUTION

THE CATHODE-RAY TUBE SHOULD BE HANDLED WITH CARE TO PREVENT BREAKAGE AND/OR SERIOUS PERSONAL INJURY FROM FLYING GLASS. DO NOT EMPLOY FORCE AT ANY TIME. AS AN ADDED PRECAUTION, IT IS ADVISABLE TO WEAR SAFETY GOGGLES AND GLOVES.

The folowing step-by-step procedure is suggested for replacing the cathode-ray tube:

1) Turn off the power and remove the side panels.

2) Remove bezel held by four screws at front panel.

3) Remove the cathode-ray tube socket and intensifier button.

4) Loosen the clamp screw at the neck of the cathode-ray tube accessible through the side of the cathode-ray tube magnetic shield.

5) Pull the cathode-ray tube straight out through the front panel.

6) Remove rubber sleeve from neck and transfer to new tube.

7) Install new tube through front-panel opening, and replace tube socket, intensifier and bezel.

8) Apply power and check the sweep; if not horizontal, rotate the tube as required using the handle attached to the socket.

9) Tighten the cathode-ray tube neck-clamp screw securely to prevent rotation of the tube.

4-5. ILLUMINATED SCALE LAMP REPLACEMENT

Defective scale lamps are removed as follows:

1. Turn off power and remove side panels.
2. Remove the appropriate lamp assembly located on the rear side of the front panel by squeezing together the spring clip. The defective bulb may then be removed and replaced.

Note: The scale lamps are connected in series-parallel. One defective lamp will cause two to be out at the same time.

4-6. SERVICING HINTS

This is a complex electronic instrument. There is no simple way of locating troubles. An understanding of the functions of the circuits is the best help. With an understanding of the circuits, you will be able to make a reasonable assumption at the general source of troubles from their symptoms.

To keep electronic units operating at top performance, it is desirable to check the equipment at regular intervals. How often it is checked, will depend on the installation and the conditions of operation. In general, portable units moved about constantly will require more frequent service than units fastened down permanently.

For these regular checks, clean all dust and dirt from the unit, using a light air blast or soft brush. Be sure that the dust is removed from around tube socket contacts and terminal strip connections.

In the event of improper equipment performance, the following suggestions are recommended:

1) Note that all tube heaters are lit, or feel tubes for warmth.

2) If the instrument fails to operate, including the pilot light, check the source of power and determine that the power cord is firmly in place. Then check the fuse at the rear of the instrument. A thermal cutout switch is incorporated only in the rack-mounted version of the Type 401-B. If the instrument has been working but has just stopped, it may have overheated and tripped the thermal cutout switch. The thermal cutout switch will reset itself when the interior temperature of the instrument drops to a

safe value. Possible causes of overheating are: restriction of air circulation and high ambient temperature.

3) If the pilot light operates but there is no spot visible there is a possibility that the spot is positioned off the screen. Check whether the beam-position-indicator lamps are operating and if the Y and X POSITION controls produce any effect. Advance the INTENSITY control and see if there is some unfocused glow on the screen to indicate operation of the CRT circuitry.

4) Localizing the trouble is made easier by use of an oscilloscope to check waveforms. Use a high-impedance Probe while trouble shooting.

5) Replacement of certain tubes may require resetting of one or more service adjustments. Consult Table 4-1. For optimum stability, the new tube should be allowed a warmup time of at least 10 minutes before making any service adjustments.

6) Maintain a high quality of workmanship. Use a clean bench and soldering iron; keep solder joints smooth and bright; do not overheat any component while soldering. Use heat sinks while soldering semi-conductors.

7) When using accessory probes or adapters, be sure the trouble is *not* originating in the accessory, before suspecting the oscilloscope itself.

8) Troubles are usually caused by tube failure and since several of the heaters are connected in series in this equipment, one may replace all suspected tubes at one time and if the trouble is corrected, return the old tubes one-at-a-time until the offending one is discovered or test each tube on a reliable tube checker. Sometimes the aftermath of tube failure yields charred resistors or overstressed capacitors. A visual inspection will usually expose the damaged component requiring replacement.

4-7. REPLACEMENT PARTS

a. Standard Parts

Replacement for all parts used in Type 401-B Oscilloscopes can be purchased directly from Du Mont. However, since most of the components are standard electronic parts, they can generally be obtained locally in less time than is required to obtain them from the factory.

If it is necessary to order a replacement component from the factory, always give the Type Number and Serial Number of the instrument. Before ordering parts for in-warranty replacement or purchasing them for out-of-warranty replacement, be sure to consult the Parts List in this Manual. The Parts List gives the values, tolerances, ratings, and Du Mont part number for all electrical components used in the instrument. This will help to expedite service.

b. Special Parts

In addition to the standard electronic components mentioned in the previous paragraph, some special parts are also used in the assembly of the Type 401-B Oscilloscopes. These parts, such as special resistor values, transformers, etc., are manufactured specially for Du Mont by other companies in accordance with Du Mont specifications. These parts and most mechanical parts should be ordered directly from Du Mont since they are normally difficult or impossible to obtain from other sources. All parts may be obtained either directly from the factory or through the local Du Mont representative.

Since the production of this instrument, some of the parts may have been superseded by improved components. In such cases, the part numbers of these new components will not be listed in your Parts List. However, if you order a part from Du Mont, and it has been superseded by an improved component, the new part will be shipped in place of the part ordered. Your local Du Mont representative has knowledge of these changes and may call you if a change in your purchase order is necessary.

It is the aim of the Du Mont organization to make available the most reliable commercial oscilloscopes within the state of the art and to provide services which will help the user to rapidly restore any Du Mont equipment to its specified performance. Your local Du Mont field representative maintains a limited number of spare parts or the factory may be asked to air ship replacement parts.

4-8. LOCATIONS OF TUBES, SERVICE ADJUSTMENTS, AND TEST POINTS

The location of tubes, service adjustments and test points are shown on the appropriate outline drawings which will be found in the last section of this Manual.

Normally, it will not be necessary to make all of the adjustments in the paragraphs to follow. However, any adjustment that is made, should be accomplished in the indicated sequence.

WARNING

WHEN THE PANELS ARE REMOVED FROM THE INSTRUMENT FOR SERVICING, EXERCISE CAUTION WHILE THE POWER IS ON. The lower-voltage busses are potentially more dangerous than the cathode-ray tube potential because of the high-current capabilities and large filter capacitors employed in these supplies. When you reach into the instrument with one hand while it is turned on, do not grasp the metal frame with the other hand. If possible, stand on an insulated floor and use insulated tools. It is advisable to ground the third lead in the power cord whenever the instrument is in use.

4-9. SERVICE ADJUSTMENTS

a. Introduction

The adjustments outlined in the following paragraphs are based on the test procedure followed at the factory.

Normally only periodic adjustment of the CAL and BALance controls will be necessary. The procedure outlined in this manual should be followed. The attenuators are factory aligned and should not be touched unless there is a positive indication that they require adjustment.

All adjustments should be made at mid-line voltage 115V/230V ± 2%.

b. Test Equipment Required (Equivalent may be substituted)

2	Volt-ohm-meters	—	Simpson Model 260 20,000 ohms/volt sensitivity
1	Square Wave Generator	—	Tektronix Type 105-A
1	Time Calibrator	—	Tektronix Type 180-A
1	Standard Amplitude Calibrator	—	Ballantine Type 420
1	High Voltage Meter	—	Sensitive Research Model DCH-1
1	Autotransformer	—	Powerstat, Variac; capable of varying line voltage of the instrument being calibrated from 103 volts to 127 volts
1	Digital Voltmeter	—	John Fluke Model 800; incremental accuracy of 0.5% or better
1	AC Voltmeter	—	Weston Model 433
1	VTVM	—	Du Mont Type 405 or equivalent

4-10. LOW-VOLTAGE POWER SUPPLY

Two separate voltage adjustments controlled by a stacked potentiometer, R3234F and R, are provided to adjust the +390V and +150V source. The +390V should be adjusted first. Two fixed voltages (—50V and +85V) are also available.

The following adjustments should be checked and readjusted if necessary. Use a John Fluke Model 800 or equivalent DC Voltmeter with an incremental accuracy of ±0.5% or better. Refer to Figures 4-1 through 4-3 and Schematic 98002101-4, Sheet 3, for location of tubes, controls and voltage points. Allow approximately twenty minutes for warmup before making any adjustments.

Preset front-panel controls as follows:

CONTROL	POSITION
X VOLTS/CM	CAL
Y VOLTS/CM	DRIV
TIME/CM	10 MS
TRIG IN	AC
TRIG LEVEL	PRESET
TRIGGER SOURCE	+ INT
VERNIERS (all three)	CAL

a. +85-Volt Supply

There is no adjustment for the + 85 volts. Its source is the Voltage Regulator V323. If this voltage reference tube is inoperative, all the other low-voltage supplies will also be inoperative.

b. +390-Volt Adjust (R3234F)

Connect voltmeter between the + 390-volt output at Pin 3 of V324 and ground. Adjust R3234F potentiometer for a meter reading of + 390 volts.

c. +150-Volt Adjust (R3234R)

This adjustment is necessary to adjust cal signal amplitude.

Connect voltmeter between the + 150-volt output at Pin 9 of V320 and ground.

NOTE: If meter reading is between 147 and 153 volts positive, do not adjust unless required to in step 4, paragraph 4-14. If outside the above limits, adjust R3234R potentiometer for a preliminary meter reading of + 150 volts. Make final adjustment as indicated in paragraph 4-14, step 4.

d. —50-Volt Supply

There is no adjustment for the — 50-volt supply. Connect voltmeter between the — 50-volt output at the negative terminal of C3300 and ground. The meter should indicate from 48 to 52 volts negative. If this reading is incorrect, trouble shooting is required.

4-11. DEFLECTION PLATE LEVEL ADJUST

The X and Y Deflection Plate Level adjustments are provided to equalize the deflection plate voltage of the cathode-ray tube for optimum spot shape. In addition, the Y DP LEVEL control is adjusted for zero volts dc at the sync take-off junction with spot centered on screen.

To make deflection plate level adjustments, proceed as follows:

a. Y DP Level Adj (R1122)

1. Set controls as indicated to obtain a dim spot on screen.

CONTROL	POSITION
X and Y VOLTS/CM	OFF
TIME/CM	OFF
X and Y VERNIER	Fully cw

2. Center beam with POSITION controls.
3. Connect Simpson 260 Multimeter set to 2.5V range between junction of sync take-off resistors (R1131 and R1132) and ground. See Figure 4-3.
4. Set DP LEVEL ADJ (R1121) for zero volts on meter. Keep beam positioned at center of screen while adjusting DP LEVEL ADJ control. Beam must rest at center of screen when meter reads zero.

b. X DP Level Adj (R1221)

1. With spot on screen, center beam with POSITION controls.
2. Remove deflection plate board cover at rear of unit.
3. Short Y Deflection Plate terminals.
4. Connect two multimeters (Simpson 260 on 250V range), one from each X Deflection Plate terminal to the now common Y Deflection Plate terminal.
5. Keeping the trace centered with the X POSITION control, adjust the X DP LEVEL potentiometer R1221 for minimum equal but opposite polarity reading on meters (less than 10 volts).
6. Increase meter sensitivity (from 250V to 10V range) to obtain more accurate readings.
7. With spot centered, final readings must be equal and less than 10 volts, with one meter reading positive, and one negative.
8. Disconnect meter and Y Deflection Plate short.

4-12. CRT POTENTIAL ADJUSTMENTS

a. Pattern Correction Adjustment

The PATTERN CORRECTION control is provided to optimize the CRT geometry for the left and right edges of the display. Refer to Figure 2-15 when making the following adjustments.

1. Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	CAL
Y VERNIER	5 cm of vertical deflection
X VOLTS/CM	OFF
TIME/CM	OFF
TRIGGER SOURCE	+ INT
TRIG LEVEL	PRESET

2. Position trace to left and right edge of scale. Check for bowing. If necessary, adjust PATTERN CORRECTION potentiometer R3108 on rear panel for the straightest line.

3. Set the X VOLTS/CM switch to AUTO and the TIME/CM switch to 20 MS/CM. Check top and bottom of pattern for bowing and pin-cushioning. The PATTERN CORRECTION potentiometer should be adjusted to give the straightest line under all conditions.

b. Astigmatism Adjustment

Adjust ASTIG potentiometer R3105 simultaneously with FOCUS control until optimized focusing of the pattern is obtained in both the horizontal and vertical plane. Keep INTENSITY at normal setting.

c. Intensity Limit Adj

1. Preset front-panel controls as follows:

CONTROL	POSITION
TIME/CM	10 MS/CM
X VOLTS/CM	AUTO
Y VOLTS/CM	CAL

2. Adjust X VERNIER control to give 6 cycles of the calibrated signal in the full scale deflection of 10 centimeters.

3. Turn INTENSITY control fully clockwise and Y VOLTS/CM to OFF.

4. Adjust INTENSITY LIMIT potentiometer R3118 from counterclockwise end to the point where the left end of the trace thickens horizontally for approximately 0.5 centimeter.

5. Turn INTENSITY control counterclockwise until the trace is barely visible.

4-13. DC BALANCE ADJUSTMENTS

When the X and Y DC BALance controls are properly adjusted, there will be no horizontal or vertical displacement of the trace with changes in setting of the VERNIER controls. If the trace shifts when VERNIER controls are rotated, the DC BALance controls should be adjusted in the following manner:

CAUTION

To avoid burn damage to cathode-ray tube, the INTENSITY should be reduced or the spot defocused while making these adjustments.

1. Turn X and Y VOLTS/CM and TIME/CM switches to OFF.

2. Set X and Y VERNIER controls fully counterclockwise.

3. Position a dim beam to center of the CRT screen.

4. While rotating Y VERNIER control R1115 right and left throughout its range, adjust the Y BAL control R1111 to recenter the spot. Correct balance is obtained when there is no depositioning of the spot with any setting of the VERNIER control.

5. Repeat step 4 using the X VERNIER, R1215, and X BAL, R1211, controls.

6. Repeat steps 4 and 5 until there is no depositioning of the beam while the VERNIER controls are rotated throughout their range.

7. To avoid selecting tubes for optimum balance, Tube Type 7730 should be used for V110, V111, V120, and V121.

4-14. CALIBRATOR AND AMPLIFIER GAIN ADJUSTMENTS

The X and Y CAL adjustments are provided to normalize the gain of the VOLTS/CM switch setting. To make calibration adjustments, proceed as follows:

1. Set Y VOLTS/CM switch to 0.01 and Y VERNIER control to CAL. position.

2. Apply a 50-millivolt output from Voltage Calibrator Ballantine Type 520, or equivalent, to Y INPUT.

3. Adjust Y CAL potentiometer R1117 for 5 centimeters of vertical deflection.

4. Reset the Y VOLTS/CM switch to CAL and adjust + 150V ADJ potentiometer R3234R, until the calibrator signal is exactly 5 centimeters.

NOTE: Whenever this adjustment is reset, then the adjustment procedure for Sweep Length, Sweep Calibration, and Sweep Expansion Point, must be repeated.

5. Turn Y VOLTS/CM switch to OFF and disconnect voltage calibrator.
6. Set X VOLTS/CM switch and VERNIER control to CAL.
7. Adjust X CAL potentiometer R1217 for 5 centimeters of horizontal deflection.

4-15. PHASE SHIFT ADJUSTMENT

A phase shift trimmer capacitor C1219 is added across the output of the horizontal deflection amplifier to adjust for zero phase differential between the X and Y amplifier at 200 Kc. To make phase shift adjustment at 200 Kc, proceed as follows:

> **NOTE**
>
> This adjustment need not be performed unless C1219 is readjusted while normalizing phase at a particular frequency during day-to-day use of the 401-B.

1. Set X and Y VOLTS/CM switches to 0.01.
2. Set X and Y VERNIER controls for maximum gain.
3. Apply 200 Kc sine wave to both the X and Y INPUTS.
4. Adjust output of generator to obtain 10 centimeters of vertical deflection.
5. Adjust PHASE SHIFT ADJ, trimmer capacitor C1219 for a closed pattern on the screen.

4-16. ATTENUATOR ADJUSTMENTS

The attenuators are factory aligned and should not be touched unless there is a positive indication that they require adjustment. If adjustment is necessary, follow the steps as outlined below.

a. Y Attenuator Adjustments

1. Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	.01
Y VERNIER	CAL
X VOLTS/CM	DRIV
X VERNIER	CAL
TRIGGER SOURCE	INT
TRIG LEVEL	PRESET
TRIG IN	AC
TIME/CM	500 μsec

2. Connect a Tektronix Type 105 Square Wave Generator to Y INPUT.
3. Set the Generator to 1 Kc and adjust its symmetry and output amplitude control to obtain a symmetrical square-wave on the screen. Observe any excess peaking on the square wave. This peaking is in the generator (Tektronix Type 105) and all succeeding adjustments must give the same waveform distortion as seen on the .01 VOLTS/CM range.
4. Set the Y VOLTS/CM switch to 0.1 and adjust the output of the generator for no more than 4 centimeters of vertical deflection. Adjust the fully clockwise trimmer C1103 for flat top on the square wave.
5. Advance in the counterclockwise direction one trimmer at a time with each setting of the Y VOLTS/CM switch, adjusting trimmers C1104 and C1105 for a flat pulse response as shown in Figure 4-0, B, below. Figures A and C show incorrect waveform.

Figure 4-0. Waveforms Encountered when Adjusting Attenuator

6. When all trimmers in the Y Circuit have been adjusted, reconnect generator to the X INPUT.

b. X Attenuator Adjustments

1. Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	0.1
Y VERNIER	As required
X VOLTS/CM	0.1
TRIG IN	AC
TIME/CM	500 μsec
TIME/CM VERNIER	CAL
TRIGGER SOURCE	— EXT
TRIG LEVEL	PRESET

2. Connect a lead from the Square Wave Generator to the TRIG IN terminals of the Type 401-B for external sync.
3. Connect a clip lead from saw take-off junction to Y INPUT (see Figure 4-3). This applies the sawtooth waveform to amplifier. Adjust for proper sweep.
4. Refer to the preceding paragraph 4-16a and repeat steps 4 and 5 except that trimmers C1203 through C1205 are adjusted for the X attenuator.
5. When all trimmers in both X and Y attenuators have been adjusted, disconnect the generator and clip lead.

4-17. TRIGGER LEVEL CENTERING ADJUSTMENT

The Trigger Level Centering adjustment determines at what voltage on the input triggering waveform, the horizontal trace will start. To make adjustment, proceed as follows:

1. Preset front-panel controls as follows:

CONTROL	POSITION
TRIGGER SOURCE	EXT/10
TRIG LEVEL	PRESET
X VOLTS/CM	DRIV

2. Clip a 620K-ohm resistor from pin 6 of V210 to ground.
3. Connect a Simpson 260 Multimeter, set on 250V dc range, from pin 1 of V211 and ground. Refer to Figure 4-3.
4. Adjust TRIG LEVEL CENT potentiometer R2113 starting from fully clockwise and rotating counterclockwise to a point where meter just indicates a positive shift.
5. When adjustment has been completed, disconnect voltmeter and resistor.

4-18. SWEEP LENGTH ADJUSTMENT

Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	CAL
TIME/CM	10 MS/CM
TIME/CM VERNIER	CAL
X VOLTS/CM	DRIV
Y VERNIER	CAL
TRIGGER SOURCE	+ INT

Adjust X VERNIER control so that both ends of sweep are on screen.

Adjust SWEEP LENGTH potentiometer R2222 for 6¼ cycles of sweep. (60 cps line.)

4-19. SWEEP CALIBRATION ADJUSTMENTS

The Sweep Calibration adjustments are provided to standardize accurately the steps of the TIME/CM switch.

1. Set X VERNIER and TIME/CM VERNIER controls to CAL.
2. Connect Sweep Calibrator, Tektronix Type 180A to Y INPUT.
3. Set TIME/CM switch to the following settings and adjust designated controls and generator for the required pattern.

TIME/CM SETTING	ADJUST CONTROL	GENERATOR SETTING
10 msec	SWP CAL (R2245R)	10 kμs — 1 mark/cm
5 μsec	5 μs CAL (C2211)	1 μs — 5 marks/cm
100 μsec	100 μs CAL (R2225)	100 μs — 1 mark/cm

4. Disconnect sweep calibrator.

4-20. SWEEP EXPANSION POINT ADJUSTMENTS

1. Set up oscilloscope for normal operation with TIME/CM switch at 10 msec.

2. Check that X BALance is properly adjusted; see paragraph 4-13.

3. Rotate X VERNIER fully counterclockwise. Position trace so it is centered vertically on the screen.

4. Rotate X VERNIER control clockwise and check that trace expands equally from center to outside edges.

5. If adjustment is necessary, adjust SWEEP EXPANSION POINT potentiometer R2245F while rotating X VERNIER control R1215 until trace expands equally from center to outside edges.

TABLE 4-1
ADJUSTMENTS TO BE MADE WHEN REPLACING TUBES

CONTROL NUMBER	SERVICE ADJUSTMENT	REF.	CONTROL NUMBER	SERVICE ADJUSTMENT	REF.
1	Y Bal	R1111	9	Sweep Length	R2222
2	X Bal	R1211	10	Sweep Expansion Point	R2245F
3	Y Cal	R1117	11	Sweep Cal	R2245R
4	X Cal	R1217	12	+ 390V	R3234F
5	Y DP Level	R1121	13	+ 150V	R3234R
6	X DP Level	R1221	14	Astigmatism	R3105
7	Phase Shift	C1219	15	Pattern Correction	R3108
8	Trig Level Centering	R2113	16	Intensity Limit	R3118

SYMBOL	TUBE TYPE	ADJUST CONTROL NUMBER
* V110	ECC82/12AU7	1, 3, 5, 7
* V111, V112	ECC82/12AU7, 6DJ8	3, 5, 7
* V120	ECC82/12AU7	2, 4, 6, 7
* V121, V122	ECC82/12AU7, 6DJ8	4, 6, 7
V210, V211	6DJ8	8
V212	6BC7	None
V213	12AU7	9
V214	6BC7	None
V215	6BR8A	9, 10, 11
V216	12AU7	None
V310	5642	None
V313	6CZ5	None
V314	12AU7	None
V315	K1931	3, 4, 14, 15, 16
V320	6BJ8	9, 10, 11, 13 (See Para. 4-14, step 4)
V321	5AR4/GZ34	None
V322	6BR8A	Complete Recalibration
V323	OG3	Complete Recalibration
V324	6AS7G	Complete Recalibration
V325	6BR8A	1, 2, 5, 6, 11

* To avoid selecting tubes for optimum balance, Tube Type 7730 should be used for V110, V111, V120, and V121

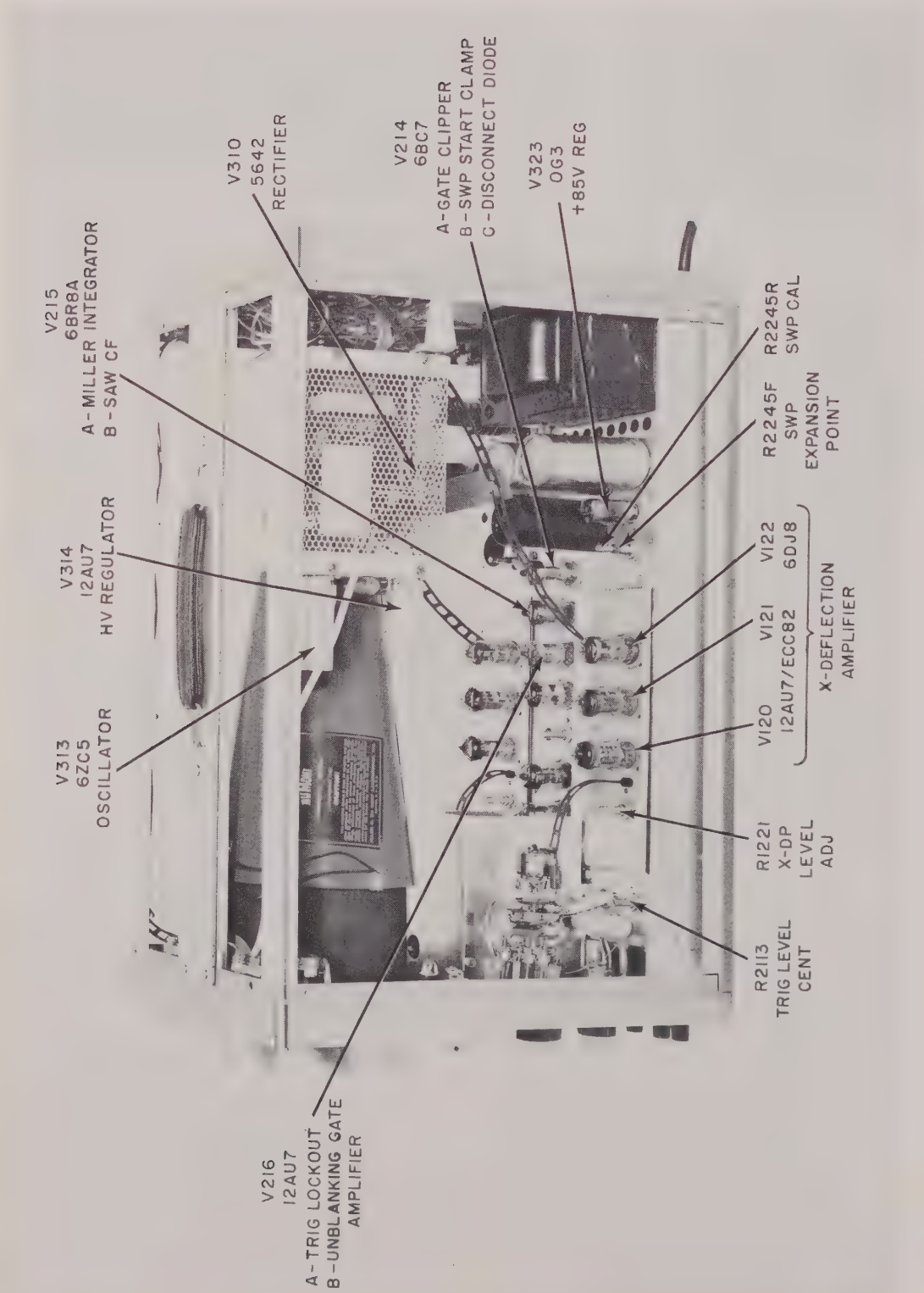


Figure 4-1. Tube Location & Service Adjustments, (Right Side)

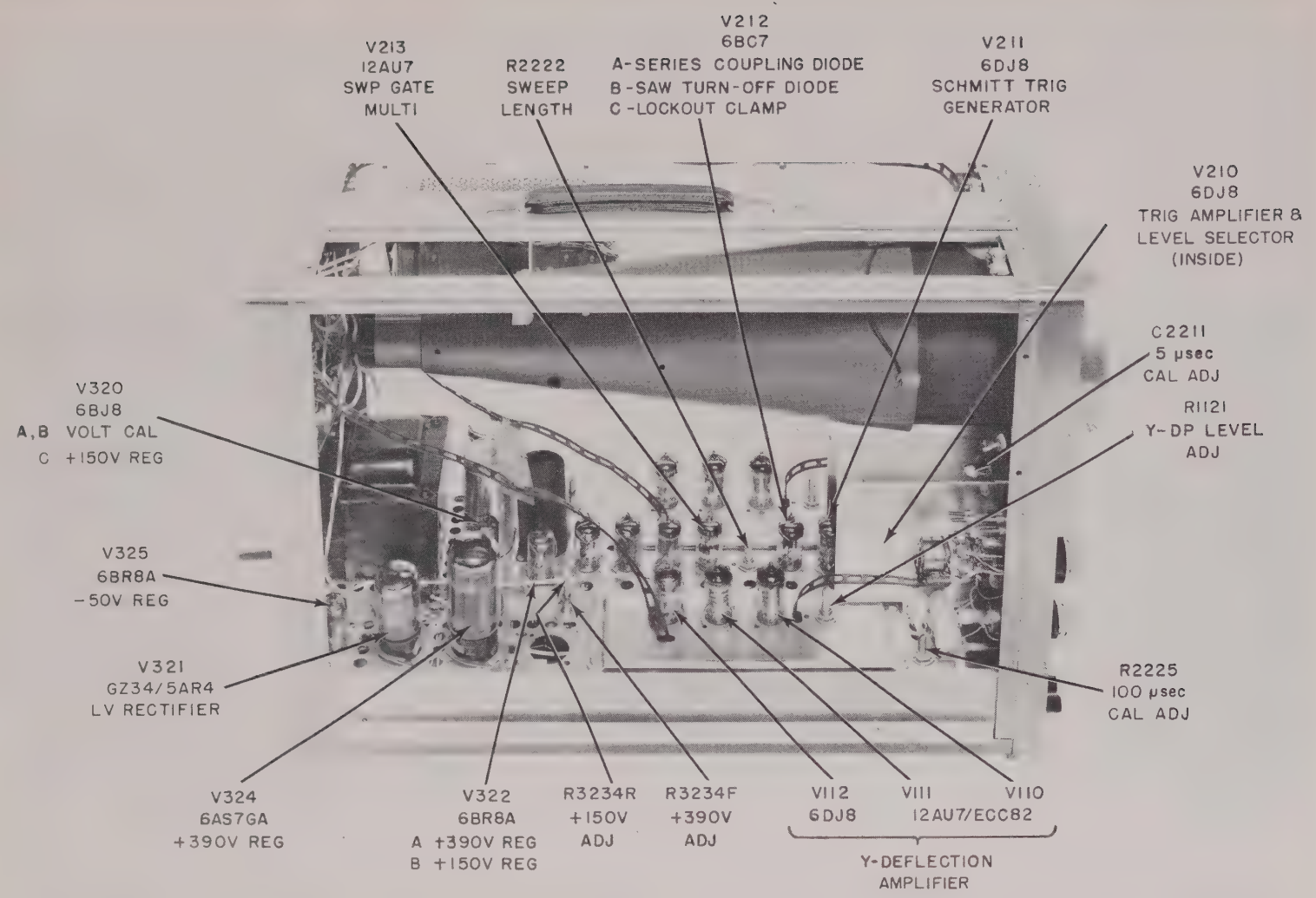


Figure 4-2. Tube Location & Service Adjustments, (Left Side)

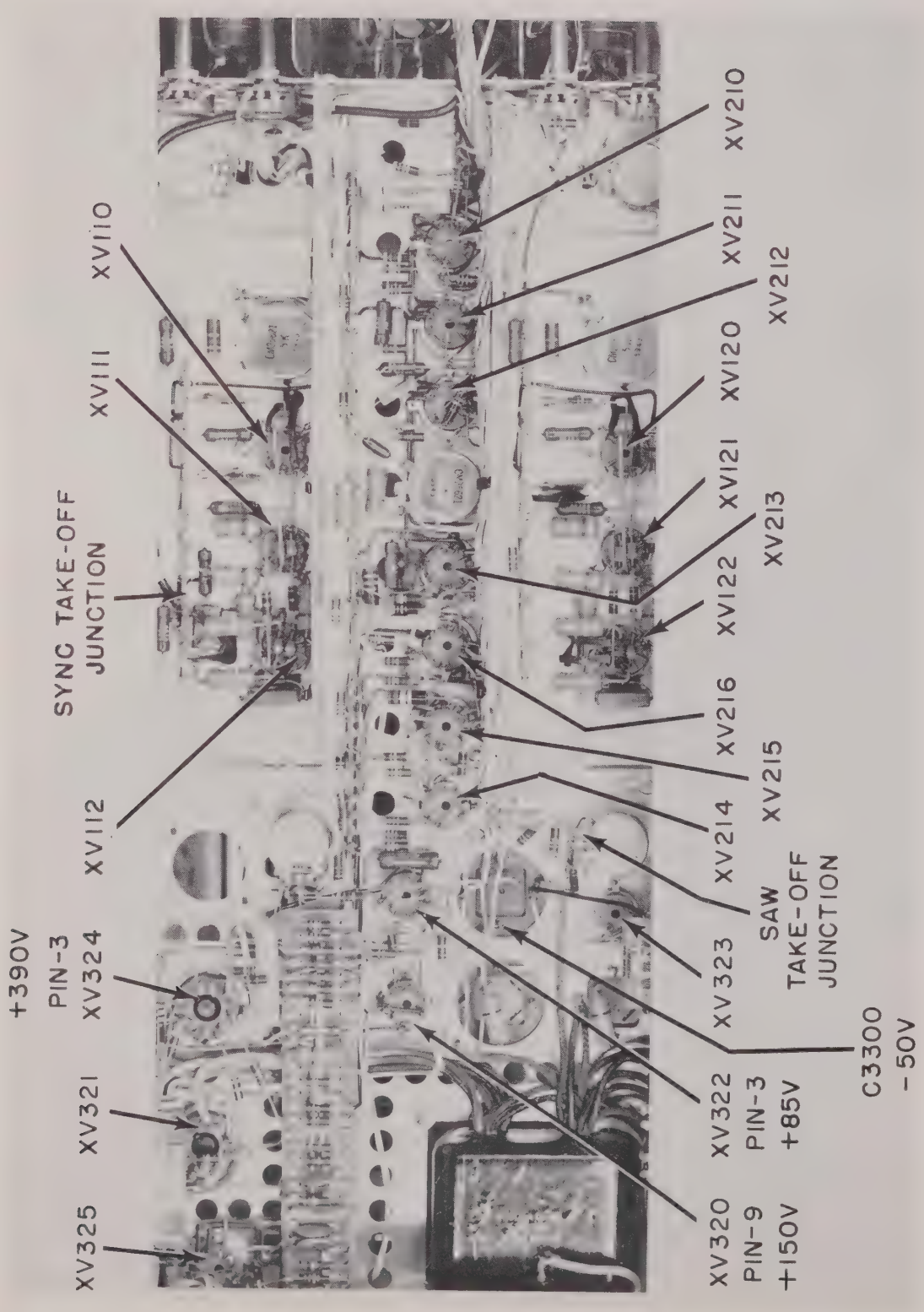


Figure 4-3. Tube Sockets & Sync Take-Off Location, (Bottom View)

SECTION V
PERFORMANCE ASSURANCE TEST

5-1. MAINTENANCE CHECK TO ASSURE PERFORMANCE

The tests described in the paragraphs to follow should be performed by Instrument Test Departments and Maintenance Laboratories to certify proper performance of the Type 401-B Oscilloscope. These tests are divided into sections for simplification and to assist those test groups where complete checking is not mandatory, or where all test equipment is not available.

NOTE

If this oscilloscope is checked by a receiving inspection laboratory, the tests outlined below are recommended to certify performance. The Type 401-B Oscilloscope has been thoroughly tested and aged at the factory. Nevertheless, rough shipment, extreme environments, or long idle periods may necessitate minor adjustments of the controls. Hence, it is suggested that the certifying engineer try the recommended adjustments not only for recentering the controls, but also to ascertain their range and to familiarize himself with this precision instrument. If, after performing all the tests outlined below, the instrument will not perform to specification, the assistance of the local Du Mont Field Engineering Representative should be requested.

5-2. CHECKING THE POWER SUPPLY

1. Check fuses for proper value.
2. Examine the instrument for charred or mechanically damaged components, loose connectors and improperly seated tubes; correct all defects.
3. Apply power to the Type 401-B Oscilloscope through a variable voltage source (Variac, or an equivalent). Set the line voltage to 115 volts. (Double this value for 230-volt operation.)
4. Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	CAL
X VOLTS/CM	DRIV
VERNIERS (all three)	CAL
TIME/CM	10 MS
TRIG IN	AC
TRIG LEVEL	PRESET
TRIGGER SOURCE	+ INT

   Six cycles of the calibrator signal should be displayed on the screen.

5. Allow 20 minutes for warmup before making any adjustments.
6. Lower the line voltage until the display starts to drift, or becomes erratic. The line voltage must be less than 103.5 volts at 60 cycles (207 volts for 230-volt operation). If instability is noted before the lower limit of the line voltage is reached, check operation of the low voltage power supplies as outlined in Section 4 of this Instruction Manual.
7. Raise the line voltage to 126.5 volts (253 volts for 230-volt operation). The display should remain stable and must not be erratic. If instability is noted before the upper limit of the line voltage is reached, check operation of the low-voltage power supplies.
8. Reset the line voltage to 115 volts (230 volts for 230-volt operation).

5-3. CHECKING THE VERTICAL AND HORIZONTAL DEFLECTION AMPLIFIERS

a. DC Balance Adjustment

1. Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	OFF
Y VERNIER	Fully ccw
TIME/CM	OFF
X VOLTS/CM	OFF
X VERNIER	Fully ccw
X and Y POSITION	Center the spot

CAUTION

Reduce INTENSITY setting or defocus spot slightly to avoid damaging the cathode-ray tube screen.

2. Rotate the Y VERNIER control fully clockwise and return beam to center of screen with the front-panel screwdriver Y BAL control.
3. Repeat several times until the spot does not move when the Y VERNIER control is rotated.
4. Repeat the above procedure for balancing the X Channel.

b. Y CAL Adjustment

1. Turn Y VOLTS/CM and Y VERNIER controls to CAL.
2. Position the ends of the trace to the two CAL marks ± 2½ cm from the center of the screen.
3. If the ends of the trace do not coincide with the marks on the scale, adjust the Y CAL control until they do. Be careful to avoid parallax errors when making this adjustment.
4. Repeat the above procedure for the X Channel.

c. Calibrate Signal Amplitude Check

1. Turn the Y VOLTS/CM switch to .01.
2. Apply a 50-millivolt peak-to-peak 1 Kc sine wave from a Ballantine Type 420 Calibrator or equivalent ± ½% accurate source to the Y INPUT.
3. The length of the trace measured between the CAL marks should be 4.9 to 5.1 centimeters. If this requirement is not met, refer to the paragraph entitled "Calibrator and Amplifier Gain Adjustments" in Section 4 of this Instruction Manual.

5-4. CHECKING THE SWEEP

a. Sweep Length Adjustment

Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	CAL
Y VERNIER	CAL
TIME/CM	10 MS/CM
(TIME/CM) VERNIER	CAL
X VOLTS/CM	DRIV
TRIGGER SOURCE	+ INT
X VERNIER	Adjusted so that both ends of the sweep can be observed

Check that between 6 and 6½ cycles of the calibrator signal (60-cycle line) are displayed on the screen. If less than 6 cycles appear, refer to Section 4 of this Instruction Manual for the SWEEP LENGTH adjustment procedure.

b. Sweep CAL Adjustment

Set the X VERNIER control to CAL and check that six cycles of the calibrator waveform (60-cycle line) occupy 9.5 to 10.5 centimeters of the horizontal scan. Exercise care to avoid parallax errors when making this measurement. If this specification is not met, remove the right-side cover and set SWEEP CAL adjustment for 6 cycles of the calibrator waveform in 10 centimeters.

c. Trigger Level Control Check

Turn the TRIG LEVEL control clockwise out of PRESET position; the trace should disappear. Rotation of this control should allow selection of this level on the positive slope of the waveform at which the sweep starts. Return TRIG LEVEL control to PRESET.

d. DC Coupled Trigger Check

Set TRIG IN switch to DC. Position the pattern vertically across the face of the tube. The point on the scale at which the pattern starts should remain constant. The pattern should disappear when it no longer crosses the trigger point. Return the TRIG IN switch to AC.

e. Trigger Polarity Check

Turn the TRIGGER SOURCE switch to — INT. Check that the sweep now starts on the negative slope of the waveform. Set the TRIGGER SOURCE switch to + LINE. The pattern should remain in sync.

f. Auto Triggering Check

Turn the TRIGGER SOURCE switch to + EXT/10. No sweep should be visible. Turn the X VOLTS/CM switch to AUTO. The display should be visible but out of sync. Return the TRIGGER SOURCE switch to — LINE. The pattern should now be in sync.

g. Checking Single Sweep

1. Turn the X VOLTS/CM switch to SINGLE. The trace should disappear and the Reset Indicator lamp should be lit.
2. Turn the TRIGGER SOURCE switch to + EXT/10 and then the X VOLTS/CM switch to RESET. The Reset Indicator lamp should go out.
3. Return TRIGGER SOURCE switch to — LINE. Only one trace should appear. The Reset Indicator lamp will now be lit.
4. Return X VOLTS/CM switch to SINGLE and repeat sequence several times with various sweep rates. Only one sweep should appear as the TRIGGER SOURCE switch is operated.

NOTE: If trigger signals are available as the X VOLTS/CM switch is turned from SINGLE to RESET; the sweep will fire immediately. If the sweep speed is high, a viewing hood may be necessary to see the single stroke of the time base.

5-5. CHECKING FREQUENCY RESPONSE OF X AND Y AMPLIFIERS

a. Y Amplifier

1. Preset front-panel controls as follows:

CONTROL	POSITION
Y VOLTS/CM	.01
Y VERNIER	CAL
TIME/CM	OFF
X VOLTS/CM	OFF

2. Connect a Test Oscillator, Hewlett Packard or equivalent, to the Y INPUT.

   NOTE: Be sure that the Type 650A is properly terminated in 600 ohms.

3. Set the generator output for approximately 0.035 volts rms, and at a sine wave frequency of 1 Kc.
4. Adjust the generator for exactly 10 centimeters of vertical deflection. Avoid parallax errors when making this adjustment.
5. Note the exact reading of the Voltmeter on the Test Oscillator.
6. Change the frequency to 500 Kc and readjust the Test Oscillator to the same reading. The trace must now displace no less than 6.3 centimeters of vertical deflection.

b. X Amplifier

1. Preset front-panel controls as follows:

CONTROL	POSITION
X VOLTS/CM	.01
X VERNIER	CAL
TIME/CM	OFF
Y VOLTS/CM	OFF

2. Connect the Test Oscillator to the X INPUT.
3. Repeat steps 3 through 6 of paragraph 5-5a using X-circuit nomenclature and control.

HANDLES, RACK
6401 2472

PANEL FRONT, RACK:
3200 9671

ACCESSORIES:

PROBE:
Type 4290

CONNECTOR:
G–R 9800 0629

SWEEP REARMING KIT:
Type 4001

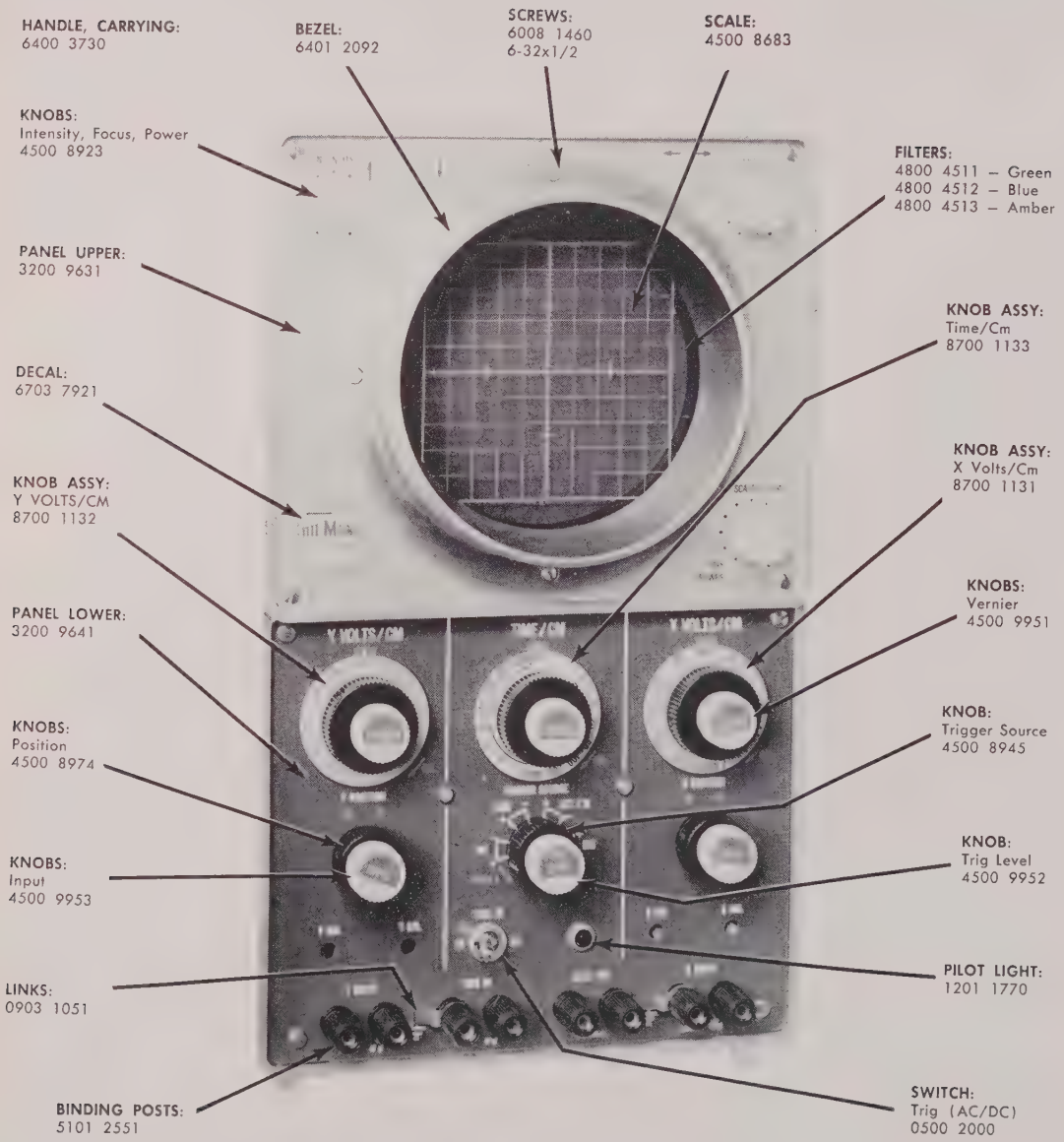


Figure 6-0. Identification of Replaceable Parts

SECTION 6

ELECTRICAL PARTS LIST AND SCHEMATICS

PARTS LIST FOR TYPES 401B/401BR OSCILLOSCOPES

CAPACITORS (1100)

Notes: 1. All capacitors are fixed, ceramic, ±10%, and 500V unless otherwise specified.

2. GMV denotes Guaranteed Minimum Value.

Symbol	Part Number	Description	Recommended Vendor Code	Type
C1101	0326 5720	plastic, 0.1 µf, 600V	GUD	#355F
C1102	0319 5870	24 µµf, ±5%	ERC	NPO332
C1103 to C1105	0316 9631	variable, glass, 1-12 µµf, 600V	ABD	
C1106	0326 6650	270 µµf	RMC	C
C1107	0316 9470	820 µµf	RMC	JL
C1108	0303 3650	mica, 8200 µµf, 300V	EIA	
C1109	0326 4640	0.01 µf, GMV	ERC	821
C1110	0319 5880	20 µµf, ±5%	ERC	NPO332
C1111	0326 4640	0.01 µf, GMV	ERC	821
C1113 & C1114	0313 3900	composition, 3.3 µµf	STC	GA
C1115 & C1116	0313 3870	composition, 2.2 µµf	STC	GA
C1117	0319 5880	20 µµf, ±5%	ERC	NPO332
C1118	0319 5960	12 µµf	ERC	NPO332
C1119	0313 3960	composition, 10 µµf	STC	GA
C1122 & C1123	0313 3870	composition, 2.2 µµf	STC	GA

CAPACITORS (1200)

Symbol	Part Number	Description	Recommended Vendor Code	Type
C1201	0326 5720	plastic, 0.1 µf, 600V	GUD	#355F
C1202	0319 5870	24 µµf, ±5%	ERC	NPO332
C1203 to C1205	0316 9631	variable, glass, 1-12 µµf, 600V	ABD	
C1206	0326 6650	270 µµf	RMC	C
C1207	0316 9470	820 µµf	RMC	JL
C1208	0303 3650	mica, 8200 µµf	EIA	
C1209	0326 4640	0.01 µf, GMV	ERC	821
C1210	0319 5880	20 µµf, ±5%	ERC	NPO332
C1211	0326 4640	0.01 µf, GMV	ERC	821
C1213 & C1214	0313 3900	composition, 3.3 µµf	STC	GA
C1215 & C1216	0313 3870	composition, 2.2 µµf	STC	GA
C1217	0319 5880	20 µµf, ±5%	ERC	NPO332
C1219	0319 6880	variable, 1.5-7 µµf, 350V	ERC	557-06 NPO
C1220	0317 5830	0.04 µf, GMV, 600V	RMC	B

CAPACITORS (2100)

Symbol	Part Number	Description	Recommended Vendor Code	Type
C2100	0319 5970	39 µµf	ERC	NPO332
C2102	0313 3920	composition, 4.7 µµf	STC	GA
C2103	0326 4520	1000 µµf, GMV	ERC	801
C2105	0326 4640	0.01 µf, GMV	ERC	821
C2106	0319 5980	47 µµf	ERC	NPO332
C2107	0326 4520	1000 µµf, GMV	ERC	801
C2108	0317 5830	0.04 µf, GMV, 600V	RMC	B
C2110	0326 4640	0.01 µf, GMV	ERC	821
C2111	0319 5970	electrolytic, 39 µµf	ERC	NPO332
C2112	0326 4540	0.0015 µf, GMV	ERC	801
C2113	0326 4520	1000 µµf, GMV	ERC	801

CAPACITORS (2200)

Symbol	Part Number	Description	Recommended Vendor Code	Type
C2200	0319 5750	62 µµf, ±5%	ERC	N220 332
C2201 & C2202	0319 5990	22 µµf	ERC	NPO332
C2203	0316 9430	390 µµf	RMC	JL
C2204	0317 4800	0.01 µf, ±20%	CRL	
C2205	0326 4660	0.02 µf, GMV	ERC	821
C2206	0326 5820	plastic, 0.47 µf, ±20%, 150V	GUD	#355Y
C2208	0313 3910	composition, 3.9 µµf	STC	GA
C2209	0305 5640	mica, 68 µµf	EIA	
C2210	0315 0530	variable, 8-50 µµf, 350V (1 µSEC CAL ADJ)	ERC	557-08
C2211	0315 0530	variable, 8-50 µµf, 350V (5 µSEC CAL ADJ)	ERC	557-08
C2213	0326 6250	plastic, 0.12 µf, ±20%, 200V	GUD	#355C
C2214	0302 2000	mica, 910 µµf, ±5%, 300V	EIA	
C2215	0316 9560	4700 µµf, 1000V	RMC	JL
C2216	0319 5990	22 µµf	ERC	NPO332
C2217	0326 5810	plastic, 0.015 µf, ±5%, 150V	GUD	#355Y
C2218	0315 6400	100 µµf, 1000V	RMC	C
C2219	0316 9430	390 µµf	RMC	JL

CAPACITORS (3100)

Symbol	Part Number	Description	Recommended Vendor Code	Type
C3100 & C3101	0316 9080	470 µµf, ±20%, 4000V	RMC	4 KV
C3102 to C3107	0316 4930	0.01 µf, +100 −0%, 2000V	RMC	2 KV
C3108	0316 8650	22 µµf, 2000V	RMC	2 KV
C3109	0319 3200	paper, 0.1 µf, 600V	ARC	DP
C3110	0316 3860	51 µµf, ±5%	RMC	C
C3111	0317 3900	1000 µµf	EIA	
C3112	0316 9410	510 µµf, 1000V	RMC	JL
C3113	0303 8580	mica, 510 µµf, 1000V	EIA	
C3114	0319 3200	paper, 0.1 µf, 600V	ARC	DP
C3115	0316 4930	0.01 µf, +100 −0%, 2000V	RMC	2 KV
C3116	0326 6450	510 µµf, ±5%	RMC	C
C3117	0316 4930	0.01 µf, 2000V	RMC	2 KV
C3121	0319 5850	27 µµf, ±5%	ERC	NPO332
C3122	0316 3870	56 µµf, ±5%	RMC	C

CAPACITORS (3200)

Symbol	Part Number	Description	Recommended Vendor Code	Type
C3200 & C3201	0326 4640	0.01 µf, GMV	ERC	821
C3203	0301 3810	1000 µµf, GMV	ERC	GP3-331
C3210	0326 4640	0.01 µf, GMV	ERC	821
C3211 & C3212	0319 4480	electrolytic, 125 µf, +100 −10%, 350V	MAL	FP
C3213	0326 4640	0.01 µf, GMV	ERC	821
C3214	0326 5710	plastic, 0.1 µf, ±20%, 600V	GUD	355F
C3215	0326 2270	electrolytic, 10 µf, +50 −10%, 450V	MAL	FP
C3216	0326 4640	0.01 µf, GMV	ERC	821
C3217	0315 7500	electrolytic, 10 µf, 250V	MAL	TC

Symbol	Part Number	Description	Recommended Vendor Code	Type
		CAPACITORS (3300)		
C3300	0314 3430	electrolytic, 150 µf, 200V	CND	UPE-15020
C3301	0326 4640	0.01 µf, GMV	ERC	821
C3302	0326 4620	5000 µµf, GMV	ERC	851
C3303	0326 4640	0.01 µf, GMV	ERC	821
C3304	0301 3300	electrolytic, 20 µf, 150V	MAL	
		CAPACITORS (3400)		
C3401 & C3402	0326 4660	0.02 µf, GMV	ERC	821
		SEMICONDUCTORS		
CR2200	2600 1530	germanium, 50 ma dc, 1N34A	EIA	
CR3101 & CR3102	2600 2711	rectifier, metallic, selenium	ABD	
CR3300	2600 6810	diode, silicon, 1N2861	EIA	
& CR3301	2600 6670	diode, 1N1763 (alternate)	RCA	
		LAMPS		
DS1101 & DS1102	1201 1900	indicator, neon, NE-2A, ¼W	ELD	1B9
DS1201 & DS1202	1201 1900	indicator, neon, NE-2A, ¼W	ELD	1B9
DS3400	1201 1280	incandescent, miniature, 2-pin 150 ma, 6.3V, GE #12	GE	#12
DS3401 to DS3404	1201 0960	incandescent, miniature bayonet, 0.16 ampere. 3.2V, #1490	GE	#1490
E2200	1200 3960	glow, NE-2, 0.3 ma, 1/25W	GE	NE-2
		FUSES		
F3200	1100 5210	3 amperes, slow-blow, 115-volt operation	BUS	
F3200	1100 5270	1.5 amperes, slow-blow 230-volt operation	BUS	
		ELECTRICAL CONNECTORS		
		BENCH AND RACK MODELS, FRONT PANEL		
J1101 to J1103	5101 2551	Binding Post (Y INPUT)	ABD	
J1201 to J1203	5101 2551	Binding Post (X INPUT)	ABD	
J2100	5101 2551	Binding Post (TRIG IN)	ABD	
J2200	5101 2551	Binding Post (GATE OUT)	ABD	
		RACK MODEL ONLY, REAR PANEL		
J4100	0903 7400	Jack tip, red (TRIG IN)	UCN	Part #118930
J4101 & J4102	0903 7400	Jack tip, red (Y INPUT)	UCN	Part #118930
J4103	0903 7410	Jack tip, black (GROUND)	UCN	Part #118930
J4200	0903 7400	Jack tip, red (GATE OUT)	UCN	Part #118930
J4201 & J4202	0903 7400	Jack tip, red (X INPUT)	UCN	Part #118930
J4203	0903 7410	Jack tip, black (GROUND)	UCN	Part #118930
		BENCH AND RACK MODELS		
P3100	0904 3841	Plug, high voltage	ABD	

RESISTORS (1100)

Notes: 1. All resistors are fixed, composition, ±5%, and ½W unless otherwise specified.

2. Resistance values in ohms: K = thousand, M = million

Symbol	Part Number	Description	Recommended Vendor Code	Type
R1101	0229 6290	film, 1M, ±1%	TEX	CD1/2MR
R1102	0229 9260	film, 124K, ±1%	TEX	CD1/2PR
R1103	0229 9270	film, 10.2K, ±1%	TEX	CD1/2PR
R1104	0229 9170	film, 1K, ±1%	TEX	CD1/2PR
R1105 & R1106	0229 6290	film, 1M, ±1%	TEX	CD1/2MR
R1107 & R1108	0203 2050	220K, ±10%	ALB	EB
R1109	0234 8490	film, 15K, ±1%	CGW	C-20
R1110	0204 1430	9.1M	IRC	BTS
R1111	0108 6010	variable, 250 (Y BAL)	CTS	Series 45
R1112 & R1113	0234 8500	film, 16K	CGW	C-20
R1114	0203 0410	510	ALB	EB
R1115	0107 2332	variable, 100K (Y VERNIER)	ABD	
R1116	0203 0620	3900	ALB	EB
R1117	0108 6110	variable, 50K, ⅓W (Y CAL)	CTS	Series 45
R1118	0203 0410	510	ALB	EB
R1119	0234 9210	film, 4700, 1W	CGW	C-32
R1120	0203 0440	680	ALB	EB
R1121	0102 1440	variable, wire wound, 5K, 2W (Y-DP LEVEL ADJ)	CLS	Series 43
R1122	0107 2321	variable, 500 (Y POSITION)	ABD	
R1123 & R1124	0239 1417	film, 62K, 2W	ABD	
R1125 & R1126	0203 1630	68, ±10%	ALB	EB
R1127	0228 4030	film, 12K, 3W	CGW	LPI-3
R1128 & R1129	0228 4130	film, 25K, 3W	CGW	LPI-3
R1131	0229 5220	film, 750K, ±1%	ELC	DC1/2B
R1132	0229 5190	film, 3.65M, ±1%	ELC	DC1/2B
R1133	0203 2070	330K, ±10%	ALB	EB
R1134 & R1135	0203 2050	220K, ±10%	ALB	EB
R1136	0203 2070	330K, ±10%	ALB	EB
R1138	0203 2010	100K, ±10%	ALB	EB
R1141	0203 1750	680	ALB	EB

RESISTORS (1200)

Symbol	Part Number	Description	Recommended Vendor Code	Type
R1201	0229 6290	film, 1M, ±1%	TEX	CD1/2MR
R1202	2029 9260	film, 124K, ±1%	TEX	CD1/2PR
R1203	0229 9270	film, 10.2K, ±1%	TEX	CD1/2PR
R1204	0229 9170	film, 1K, ±1%	TEX	CD1/2PR
R1205 & R1206	0229 6290	film, 1M, ±1%	TEX	CD1/2MR
R1207 & R1208	0203 2050	220K, ±10%	ALB	EB
R1209	0234 8490	film, 15K	CGW	C-20
R1210	0204 1430	9.1M	IRC	BTS
R1211	0108 6010	variable, 250 (X BAL)	CTS	Series 45
R1212 & R1213	0234 8500	film, 16K	CGW	C-20
R1214	0203 0410	510	ALB	EB
R1215	0107 2332	variable, 100K (X VERNIER)	ABD	
R1216	0203 0620	3900	ALB	EB
R1217	0108 6110	variable, 5K, ⅓W (X CAL)	CTS	Series 45
R1218	0203 0410	510	ALB	EB
R1219	0234 9210	film, 4700, 1W	CGW	C-32
R1220	0203 0440	680	ALB	EB
R1221	0102 1440	variable, wire wound, 5K, 2W (X-DP LEVEL ADJ)	CLS	Series 43
R1222	0107 2321	variable, 500 (X POSITION)	ABD	

Symbol	Part Number	Description	Recommended Vendor Code	Type
R1223 & R1224	0239 1417	film, 62K, 2W	ABD	
R1225 & R1226	0203 1630	film, 68, ±10%	ALB	EB
R1227	0228 4030	film, 12K, 3W	CGW	LPI-3
R1228 & R1229	0228 4130	film, 25K, 3W	CGW	LPI-3
R1230	0203 1690	220, ±10%	ALB	EB
R1233	0203 2070	330K, ±10%	ALB	EB
R1234 & R1235	0203 2050	220K, ±10%	ALB	EB
R1236	0203 2070	330K, ±10%	ALB	EB
R1241	0203 1750	680	ALB	EB

RESISTORS (2100)

R2100	0204 1190	910K	IRC	BTS
R2101	0204 0970	110K	IRC	BTS
R2102	0203 0720	10K	ALB	EB
R2103	0204 1200	1M	IRC	BTS
R2104	0203 1730	470, ±10%	ALB	EB
R2105	0203 0960	100K	ALB	EB
R2106	0107 2333	variable, 1M (TRIG LEVEL)	ABD	
R2107	0203 1070	300K	ALB	EB
R2108	0203 0880	47K	ALB	EB
R2109	0203 1000	150K	ALB	EB
R2110	0203 2050	220K, ±10%	ALB	EB
R2111	0203 0840	33K	ALB	EB
R2112	0203 0810	24K	ALB	EB
R2113	0108 6030	variable, 1K (TRIG LEVEL CENT)	CTS	Series 45
R2114	0203 1730	470, ±10%	ALB	EB
R2115	0203 0840	33K	ALB	EB
R2116 & R2117	0203 0810	24K	ALB	EB
R2118 & R2119	0203 1970	47K, ±10%	ALB	EB
R2122	0203 1730	470, ±10%	ALB	EB
R2123	0203 0560	2200	ALB	EB
R2124	0234 5650	film, 196K, ±1%	CGW	NI-20
R2125	0239 0313	film, 200K, ±1%	ABD	
R2126	0203 1270	2M	ALB	EB
R2127	0203 0670	6200	ALB	EB
R2128	0203 1730	470, ±10%	ALB	EB
R2129	0234 9330	film, 15K, 1W	CGW	C-32

RESISTORS (2200)

R2200	0203 2200	3.9M, ±10%	ALB	EB
R2201	0239 0357	film, 274K, ±1%	ABD	
R2202	0203 2250	10M, ±10%	ALB	EB
R2203	0203 1730	470, ±10%	ALB	EB
R2204	0239 0313	film, 200K, ±1%	ABD	
R2205 & R2206	0203 0520	1500	ALB	EB
R2207	0203 0820	27K	ALB	EB
R2208	0203 1020	180K	ALB	EB
R2209	0203 0800	22K	ALB	EB
R2211	0234 9390	film, 27K, 1W	CGW	C-32
R2212	0239 0314	film, 243K, ±1%	ABD	
R2213	0203 1020	180K	ALB	EB
R2214	0203 0920	68K	ALB	EB
R2215	0203 1090	360K	ALB	EB
R2216	0239 0312	film, 140K, ±1%	ABD	
R2217	0203 0880	47K	ALB	EB
R2218	0203 1050	240K	ALB	EB
R2221	0228 4100	film, 30K, 3W	CGW	LPI-3
R2222	0102 1440	variable, wire wound, 5K, 2W (SWEEP LENGTH)	CLS	Series 43
R2223	0239 0326	film, 5100, ±1%	ABD	
R2224	0203 0950	91K	ALB	EB
R2225	0108 6100	variable, 25K, ⅓W (100 μSEC CAL)	CTS	Series 45
R2226	0203 0700	8200	ALB	EB
R2227	0107 2361	variable, 50K (VERNIER)	ABD	
R2228 & R2229	0234 2300	film, 1.25M, ±1%	IRC	MDB
R2231	0234 2310	film, 2.5M, ±1%	IRC	MDB
R2232	0228 8370	film, 7.5M, ±1%	IRC	MDC
R2233	0229 9900	film, 12.5M, ±1%, 1W	IRC	MDF
R2234	0229 9910	film, 25M, ±1%, 1W	IRC	MDF
R2235	0203 1650	100, ±10%	ALB	EB
R2236	0203 5020	120K, ±10%, 1W	ALB	GB
R2237	0203 2010	100K, ±10%	ALB	EB
R2238	0203 2110	680K, ±10%	ALB	EB
R2239	0203 1650	100, ±10%		
R2242	0203 1020	180K	ALB	EB
R2243	0203 0820	27K	ALB	EB
R2244	0239 1425	film, 120K, 2W	ABD	
R2245 F, R	0108 6850	variable, 250K/2.5K, 1W (SWP EXPANSION POINT AND SWP CAL)	CTS	Series CT-90 CV
R2246	0203 0550	2K	ALB	EB
R2247	0203 0360	330	ALB	EB
R2248	0203 0620	3900	ALB	EB
R2250	0203 1020	180K	ALB	EB
R2251	0203 0860	39K	ALB	EB
R2252	0203 1090	360K	ALB	EB
R2253	0203 1160	680K	ALB	EB
R2254	0203 0620	3900	ALB	EB
R2255	0203 0760	15K	ALB	EB

RESISTORS (3100)

R3100	0203 5180	2.7M, ±10%, 1W	ALB	GB
R3101	0107 1374	variable, 5M (FOCUS)	ABD	
R3102	0203 5180	2.7M, ±10%, 1W	ALB	GB
R3103	0203 1890	10K, ±10%	ALB	EB
R3104	0203 2170	2.2M, ±10%	ALB	EB
R3105	0108 6460	variable, 200K, 1W (ASTIG)	CTS	Series 90 CV
R3106	0229 3760	film, 10M, ±1%, 2W	TEX	CDH2
R3107	0229 4960	film, 4.02M, ±1%	ELC	DC1/2B
R3108	0108 6460	variable, 200K, 1W (PATTERN CORR)	CTS	Series 90 CV
R3109	0203 2090	470K, ±10%	ALB	EB
R3110	0210 0770	wire wound, 3.3, ±10%	IRC	BW1/2
R3111	0211 2260	wire wound, 2K, ±10%, 5W	MAL	HHJ
R3112	0203 2010	100K, ±10%	ALB	EB
R3113	0203 1890	10K, ±10%	ALB	EB
R3114 & R3115	0203 2090	470K, ±10%	ALB	EB
R3116	0234 2640	wire wound, 36K, ±10%, 5W	DAL	CS-5
R3117	0203 1440	10M	ALB	EB
R3118	0108 6200	variable, 1M (INTENSITY LIMIT)	CTS	Series 45
R3119	0108 6300	variable, 500K (INTENSITY)	CTS	Series 45
R3120	0203 2010	100K, ±10%	ALB	EB
R3121 & R3122	0203 7300	2.7M, 2W	ALB	GB
R3123	0203 1770	1K, ±10%	ALB	EB
R3124	0203 1030	200K	ALB	EB
R3125	0203 1610	47, ±10%	ALB	EB
R3126	0203 1910	15K, ±10%	ALB	EB

RESISTORS (3200)

R3200	0239 1501	film, 560K, ±10%, 2W	ABD	
R3201	0203 2130	1M, ±10%	ALB	EB
R3202	0203 1930	22K, ±10%	ALB	EB
R3203	0229 6140	film, 2M, ±1%	TEX	CD1/2MR
R3205	0234 5620	film, 668, ±1%	CGW	NI-20
R3207	0203 1000	150K	ALB	EB
R3210	0203 2130	1M, ±10%	ALB	EB
R3219	0203 1220	1.2M	ALB	EB
R3220	0203 1940	27K, ±10%	ALB	EB

Symbol	Part Number	Description	Recommended Vendor Code	Type
R3221 & R3222	0239 1491	film, 100K, ±10%, 2W	ABD	
R3223	0203 1280	2.2M	ALB	EB
R3224	0203 1050	240K, ±10%	ALB	EB
R3225	0203 0950	91K	ALB	EB
R3226	0203 1340	3.9M	ALB	EB
R3227	0234 9340	film, 16K, 1W	CGW	C-32
R3228	0228 7430	wire wound, 3500, 20W	TRU	MOR-20
R3229	0203 1730	470, ±10%	ALB	EB
R3230	0203 1590	33, ±10%	ALB	EB
R3231	0203 2130	1M, ±10%	ALB	EB
R3232	0239 1406	film, 24K, 2W	ABD	
R3233	0203 1250	1.6M	ALB	EB
R3234 F, R	0108 6650	variable, 1M/1M (+390V ADJ, +150V ADJ)	CTS	Series CT-45
R3235	0203 1160	680K	ALB	EB
R3236	0203 1030	200K	ALB	EB
R3237	0230 2650	film, 22K, ±10%, 7W	CGW	LPI-7
R3240	0239 1384	film, 3600, 2W	ABD	
R3241	0203 2090	470K, ±10%	ALB	EB
R3242	0203 1510	20M	ALB	EB
R3243 & R3244	0203 1730	470, ±10%	ALB	EB
R3245	0203 1010	160K	ALB	EB
R3246	0203 1080	330K	ALB	EB
R3247	0203 0880	47K	ALB	EB
R3248	0203 0790	20K	ALB	EB
R3249	0234 9430	film, 39K, 1W	CGW	C-32

RESISTORS (3300)

R3300	0239 0371	film, 182K, ±1%	ABD	
R3301	0239 0348	film, 110K, ±1%	ABD	
R3302	0203 0720	10K	ALB	EB
R3303	0203 0830	30K	ALB	EB
R3304	0203 1770	1K, ±10%	ALB	EB
R3305	0203 1150	620K	ALB	EB
R3306	0203 1060	270K	ALB	EB
R3307	0203 0760	15K	ALB	EB
R3308	0239 1417	film, 62K, 2W	ABD	
R3309	0203 1730	470, ±10%	ALB	EB
R3310	0203 1590	33, ±10%	ALB	EB
R3311	0203 1270	2M	ALB	EB
R3312	0203 4420	8.2M, 1W	ALB	GB
R3313	0203 4410	7.5M, 1W	ALB	GB
R3315	0228 7400	wire wound, 910, 20W	TRU	MOR-20
R3316	0203 1730	470, ±10%	ALB	EB

RESISTORS (3400)

R3400 & R3401	0203 1770	1K, ±10%	ALB	EB
R3402	0107 2341	variable, wire wound, 50, ±10%, 2W (SCALE)	ABD	
R3403 & R3404	0203 1770	1K, ±10%	ALB	EB
R3405	0210 5120	wire wound, 3.3, ±10%, 2W	IRC	BW-2

SWITCHES

S110	0501 6071	assembly, rotary, 30°, 2 decks, including (S112 & R1115) (Y VOLTS/CM)	ABD	
S111 (R1122)	0107 2321	SPST (part of R1122) (INPUT)	ABD	
S112 (R1115)	0107 2332	SPDT (part of R1115)	ABD	
S120	0501 6091	assembly, rotary, 30°, 5 decks, including (S122 & R1215) (X VOLTS/CM)	ABD	
S121 (R1222)	0107 2321	SPST (part of R1222) (INPUT)	ABD	
S122 (R1215)	0107 2332	SPDT (part of R1215)		
S210	0501 6081	assembly, rotary, 30°, 2 decks, including (S212 & R2106) (TRIGGER SOURCE)	ABD	
S211	0501 6421	slide, 3 positions (TRIG IN, AC/DC, ACF)	ABD	
S212 (R2106)	0107 2333	SPST (part of R2106)	ABD	
S221	0501 6411	rotary, 20°, 2 decks (TIME/CM)	ABD	
S222 (R2227)	0107 2361	SPDT (part of R2227)	ABD	
S3200 (R3402)	0107 2341	SPST (part of R3402) (POWER)	ABD	
S4000	0503 1200	relay, thermal	KXM	20200 L1
S4100	0503 1330	slide, DPDT (FRONT-REAR)	STC	SS-50
S4200	0503 1330	slide, DPDT (FRONT-REAR)	STC	SS-50

TRANSFORMERS

T3100	2001 3612	high voltage	ABD	
T3200	2001 3592	power	ABD	

ELECTRON TUBES

V110 & V111	2501 1610	7730/12AU7 (Yellow Dot)	AMX	
V112	2501 2220	ECC88/6DJ8	AMX	
V120 & V121	2501 1610	7730/12AU7 (Yellow Dot)	AMX	
V122	2501 2220	ECC88/6DJ8	AMX	
V210 & V211	2501 2220	ECC88/6DJ8	AMX	
V212	2500 8250	6BC7	EIA	
V213	2500 8220	12AV7	EIA	
V214	2500 8250	6BC7	EIA	
V215	2501 1980	6BR8A	EIA	
V216	2501 1610	7730/12AU7	AMX	
V310	2500 5740	5642	EIA	
V313	2501 1670	6CZ5	EIA	
V314	2501 1610	7730/12AU7	AMX	
V315*	2501 2510	K1931-P1	ABD	K1931P—
	2501 2520	K1931-P2	ABD	K1931P—
	2501 2530	K1931-P7	ABD	K1931P—
	2501 2540	K1931-P11	ABD	K1931P—
	2501 2550	K1931-P31	ABD	K1931P—
	2501 2770	K1931-P1 (MET)	ABD	K1931 Metallic 5KV
	2501 2780	K1931-P2 (MET)	ABD	K1931 Metallic 5KV
	2501 2790	K1931-P7 (MET)	ABD	K1931 Metallic 5KV
	2501 2800	K1931-P11 (MET)	ABD	K1931 Metallic 5KV
	2501 2810	K1931-P31 (MET)	ABD	K1931 Metallic 5KV

*Depending on sales order.

V320	2501 1970	6BJ8	EIA	
V321	2501 1560	5AR4/GZ-34	AMX	
V322	2501 1980	6BR8A	EIA	
V323	2500 9270	OG3/85A2	AMX	
V324	2501 0200	6AS7-GA	EIA	
V325	2501 1980	6BR8A	EIA	

CABLE

W3200	5026 9641	assembly, power	ABD	

LIST OF RECOMMENDED VENDORS

CODE	NAME
AER	Aerovox Corporation
ALD	Alden Electronic & Impulse Recording Equipment Company
ALB	Allen-Bradley Company
ABD	Allen B. Du Mont Laboratories
AST	Astron Corporation
APC	American Phenolic Corporation
AMX	Amperex Electronic Corporation
AMR	Amperite Company, Inc.
APH	Amphenol Electronics Corporation
ARC	Arco-Elemence
AHH	Arrow-Hart & Hegeman Electric Company
BUS	Bussmann Mfg. Co.
CBS	CBS-Hytron Division of CBS
CST	Chicago Standard Transformer
CRL	Centralab, Division of Globe-Union Inc.
CTS	Chicago Telephone Supply Corporation
CPC	C. P. Clare & Company
CLS	Clarostat Mfg. Co., Inc.
CND	Cornell-Dubilier Electric Corporation
COC	Continental Carbon
CGW	Corning Glass Works
DAG	Dage Electric Company, Inc.
DAL	Dale Products, Inc.
DLC	Dialight Corporation
EBY	Hugh H. Eby, Inc.
EIA	Any manufacturer meeting EIA standards
ELD	Eldema Corporation
ELC	Electra Mfg. Company
EMC	Electro Motive Mfg. Company
ERC	Erie Resistor Corporation
ESX	Essex Electronics
GE	General Electric Company
GRC	General Radio Company
GRY	Grayhill, Inc.
GUD	The Gudeman Company
HPC	Hewlett-Packard Company
IRP	International Rectifier Corporation
IRC	International Resistance Company
JEF	Jeffers Electronics, Inc.
JWM	J. W. Miller Co.
KXM	Klixon Metals and Control Corporation
LFI	Littlefuse, Inc.
MAL	P. R. Mallory & Company, Inc.
MUC	Mucon Corporation
NYT	New York Transformer Company, Inc.
OAK	Oak Mfg. Company
PHC	Philco Corporation
PHI	Philips Electronic Tube Division
POT	Potter & Brumfield, Inc.
RCA	Radio Corporation of America
RMC	Radio Materials Corporation
ROY	Royal Electric Corp., Inc.
SPG	Sprague Products Company
SLT	Sealectro Corporation
STC	Stackpole Carbon Company
STW	Standard Winding Company
SYL	Sylvania Electric Products, Inc.
SUM	Summit Coil Company
TEX	Texas Instruments, Inc.
TRS	Tresco, Inc.
TRU	Tru-Ohm Products
TUG	Tung-Sol Electric Inc.
UCN	Ucinite Co.
WDL	Ward Leonard Electric Company
WES	Weston Electrical Instrument Corporation

DU MONT

INSTRUMENT WARRANTY AND SERVICE NOTICE

WARRANTY

Allen B. Du Mont Laboratories warrants that each new Cathode-ray Oscilloscope, Automotive Test Equipment, and other Electronic or Electrical Test or Measuring Equipment (hereinafter referred to as "Instrument") manufactured or sold by it, is free from defects in material or workmanship under normal use and service for a period of one year from the date of its sale to the first purchaser for use. If, upon examination by Du Mont, the Instrument is determined to be defective in workmanship or material, Du Mont will, subject to the conditions set forth below, either repair the defective part or replace it with a new part. Du Mont shall not be liable for any delay or failure to furnish a replacement part resulting directly or indirectly from any governmental restriction, priority or allocation or any other governmental regulatory order or action, nor shall Du Mont be liable for damages by reason of the failure of the Instrument to perform properly or for any consequential damages. This warranty does not apply to any Instrument that has been subject to negligence, accident, misuse or improper installation or operation or that in any way has been tampered with, altered or repaired by any person other than an authorized Du Mont service organization or an employee thereof, or to any Instrument whose serial number has been altered, defaced or removed, or to any Instrument purchased within, and thereafter removed beyond, the continental limits of the United States.

This warranty shall, at Du Mont's option, become void unless registration thereof is promptly effected as provided below. This warranty is in lieu of all other warranties, expressed or implied, and no one is authorized to assume any liability on behalf of Du Mont or impose any obligation upon it in connection with the sale of any Instrument, other than as stated above.

REGISTERING THE WARRANTY

To register this warranty, the enclosed warranty registration card must be properly filled out and mailed to the Instrument Service Department immediately upon receipt of the equipment. Complete information is necessary. BOTH THE TYPE NUMBER AND THE SERIAL NUMBER OF THE INSTRUMENT MUST BE GIVEN ON THIS CARD. Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time and to furnish merchandise in accordance with current specifications without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications excepting under the classification of special apparatus.

SERVICE

In order to insure service under our warranty, the enclosed warranty service card must be properly filled out and returned to the factory. In all cases where service or adjustment is requested, please first contact the factory or authorized depot, giving complete information concerning the nature of the failure and describing the manner in which the equipment was used when failure occurred. THE TYPE NUMBER AND SERIAL NUMBER of the equipment must also be given. In this way, much time can be saved and unnecessary inconvenience often avoided. When writing to the factory in this respect, address:

ALLEN B. DU MONT LABORATORIES
Divisions of Fairchild Camera and Instrument Corporation
Industrial Electronics Division
750 Bloomfield Avenue, Clifton, New Jersey

The Instrument Service Department will then send to the customer the written procedure for disposition and shipping instructions. All equipment should be packed and shipped in accordance with this procedure; and identification tags should be attached to each tube or instrument.

REPLACEMENT PARTS

If it is necessary to order a replacement component from the factory, always give the Type number and Serial number of the Instrument. Before ordering parts for in-warranty replacement or purchasing them for out-of-warranty replacement, be sure to consult the Parts List in the Instruction Manual. The Parts List gives the values, tolerances, ratings, and Du Mont part number for all electrical components used in the Instrument. This will help to expedite service.

ALLEN B. DU MONT LABORATORIES
Divisions of Fairchild Camera and Instrument Corporation
Industrial Electronics Division
750 Bloomfield Avenue, Clifton, New Jersey

PATENT NOTICE

Manufactured under one or more U. S. Patents owned or controlled by Allen B. Du Mont Laboratories, Divisions of Fairchild Camera and Instrument Corporation, 750 Bloomfield Avenue, Clifton, New Jersey, U.S.A. Patent Numbers supplied upon request.

ADDENDUM

FOR INSTRUCTION MANUAL OF

TYPES 401-B/401-BR OSCILLOSCOPES

1. TEXT CHANGES

a. Table 1-1

The Technical Summary is revised as follows:

SYNCHRONIZATION

TRIG INPUT COUPLING

AC	High-pass filter; low-frequency cutoff of 80 cycles
DC	Direct coupled to: (1) preserve very low frequencies, (2) maintain the initial reference position of the trace with respect to the CRT scale at a given trigger level setting; and (3) avoid trigger point variations due to random repetition rate trigger signals
ACF	AC Fast differentiated trigger input; high-pass filter is provided to reject hum and low-frequency amplitude modulation; low-frequency cutoff nominally 10 Kc

SWEEP CIRCUIT

TIME BASE

Calibrated	From 200 milliseconds/cm to 1 microsecond/cm in 17 steps. Step sequence is 1, 2, 5, and 10. An "off" position is included
Sweep Expansion	5 times expansion. Continuously variable from less than 0.8 to greater than 5. Extends fastest sweep rate to 0.2 microsecond/cm within ±10%. Optional modification available to calibrate the maximum expansion to X5 ±2%. See paragraph 3 of this Addendum.

b. TRIG IN Switch

A TRIG IN control has been added to the instrument. This is a 3-position slide switch and provides the following modes of trigger coupling:

1. AC: this mode may be used for general-purpose trigger coupling. The low-frequency cutoff is approximately 80 cycles to avoid disturbing internal triggering while vertically positioning the pattern.
2. ACF: this mode is used primarily to reject low-frequency amplitude modulations in the trigger source. In the ACF position, a high-pass filter is inserted which rejects low-frequency components below 10 Kc. When used with signals having insignificant signal content above 10 Kc, such as the internal line frequency calibrator, unsatisfactory triggering will result.
3. DC: this mode is used to maintain the initial reference position of the trace on the CRT scale at a given trigger level setting; and to avoid the effects of random repetition rate trigger signal.

c. Summary of AC, ACF, and DC Triggering Modes

In summary, the following statements may be made to compare the AC, ACF, and DC modes of triggering:

1. When using the AC mode, the TRIG IN switch is set to AC, the trace always starts at the same point on the *Waveform* for a given TRIG LEVEL control setting regardless of the vertical positioning.

2. When using the DC mode, the TRIG IN switch is set to DC, the trace always starts at the same point on the *Scale* for a given setting of the TRIG LEVEL control regardless of the vertical positioning.

3. The DC mode is especially useful for viewing waveforms which change very slowly and which are therefore discriminated against by the low-frequency cutoff of the AC position (80 cps). Because of the coupling network time constant in the AC mode, signals having random repetition rates are sometimes viewed more stably in the DC mode.

4. The ACF mode is a special high-frequency form of the AC mode and is used to reject low-frequency components in the triggering signal. Always use AC triggering unless low-frequency rejection is required. Triggering signals with frequency components below 10 Kc, for example, the internal calibrator signal, will not initiate the sweep circuits when the ACF mode is used.

2. TYPE 4001 SWEEP REARMING KIT

a. Installation

The Du Mont Type 4001 Sweep Rearming Kit has been designed to enable the sweep to be armed remotely by means of a contact closure introduced through the two-contact socket (J2300) to be installed on the rear deflection plate board as part of this kit installation. This kit enables the operator to rearm the sweep from the Du Mont Type 450 Camera, contacts on rotating machinery, etc.

To install the Sweep Rearming Kit, follow the steps outlined and refer to the wiring diagram shown in paragraph c.

1. Set the oscilloscope on a bench with the bottom up. Locate the area in which the Kit parts are to be installed.

2. Connect the center conductor of the RF Cable supplied, to Point A.

3. Connect the buss wire which is soldered to the shield, to the terminal board mounting foot Point C. Optional ground points on sockets XV212 or XV213 may be used if desired.

4. Run cable back alongside terminal boards, under the Erie board, up through rear transformer ventilating hole to area of cutout on the rear deflection plate board.

5. Install connector (J2300) on rear deflection plate board using the hardware provided.

6. Dress the coaxial cable up to the connector and solder the center conductor to the *top* terminal of the connector.

7. Connect the buss wire, which is soldered to the shield, to the bottom terminal (indicated with ground symbol) of the connector.

8. Connect a jumper lead between points B and D. This connection applies +150 volts to point B.

9. Connect the 91-megohm resistor (R2300) across points A and B.

10. Connect the 3.9 pf capacitor (C2300) from pin 2 of V213 (point E) to terminal board point A.

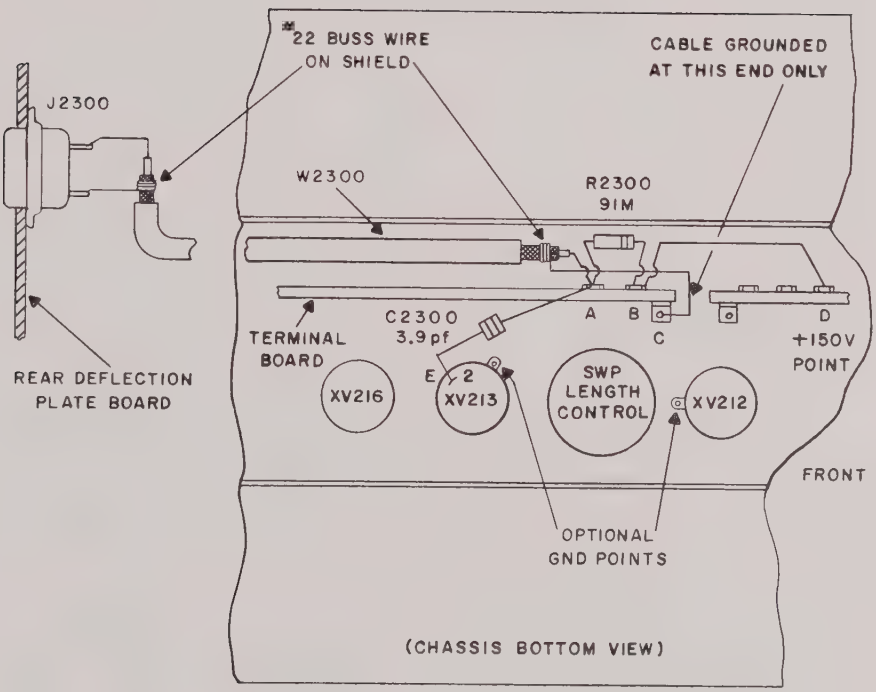
This completes the installation of the Sweep Rearming Kit.

b. Parts List

SYMBOL	PART NUMBER	DESCRIPTION
C2300	0313 3910	Capacitor, fixed, composition, 3.9 pf. ±10% 500V
R2300	0204 2300	Resistor, fixed, composition, 91 megohms, ±20%, ½W
J2300	0901 5560	Connector, receptacle, female 2 contacts
W2300	5029 6240	Cable, RF
.....	6009 8570	Screw, binder head, 6-32 x ⅜
.....	6210 0030	Washer, lock #6
.....	6100 0600	Nut, hex, 6-32

NOTE: A schematic of the Type 4001 Sweep Rearming Kit is shown on Schematic drawing 9800 2101-4, Sheet 2 of 3.

c. Wiring Diagram, Type 4001 Sweep Rearming Kit



3. TYPE 4003 MAXIMUM SWEEP EXPANSION CALIBRATION KIT

a. Installation

A schematic of the Du Mont Type 4003 is shown on Schematic Drawing 9800 2101-4, Sheet 2 of 3.

Mount R2500, R2501, and R2502 on terminals of switch attached to R1215 the X VERNIER control.

b. Sequence of Adjustments

Adjust X5 Expansion first (R2245R).

Adjust X1 Expansion next (the new 500-ohm pot, R2502).

c. Parts List

SYMBOL	PART NUMBER	DESCRIPTION
(Added) R2500	0203 0440	Resistor, fixed, composition, 680 ohms, ±5%, ½W Allen Bradley, Type EB
(Added) R2501	0203 0420	Resistor, fixed, composition, 560 ohms, ±5%, ½W Allen Bradley, Type EB
(Added) R2502	0106 7600	Resistor, variable, composition, 500 ohms, ±20%, 0.1W Centralab, Model 1
(Changed) R2246	0203 0590	Resistor, fixed, composition, 3000 ohms, ±5%, ½W Allen Bradley, Type EB
(Changed) R2248	0203 0560	Resistor, fixed, composition, 2200 ohms, ±5%, ½W Allen Bradley, Type EB

4. SPARE PARTS REQUIREMENTS

a. General

Your Du Mont Type 401-B Oscilloscope is an extremely reliabele and dependable instrument. Only components thoroughly tested by the engineers of the Du Mont Quality Assurance Department are used in your instrument. Continued performance, environmental and life testing of production units make certain your oscilloscope will give many years of satisfactory service. These new Du Mont oscilloscopes are precision engineered and require no selected parts.

Two lists of "running spares" are included to aid you in period maintenance. The running-spare parts lists include recommended quantities and reference symbol numbers. Section 6 of this Instruction Manual gives a complete listing of all components and their recommended vendors so that you may readily procure them from a local supply house or your own stores.

NOTE: Your local Du Mont representative and his service organization can assist you in obtaining any additional components in the shortest possible time.

b. 500-Hour Spares (6 months)

The recommended list for one through 3 units is given below.

Fuses

SYMBOL	QUANTITY
F3200 (115V operation)	4 each
F3200 (130V operation)	4 each

Electron Tubes

TYPE	QUANTITY	
7730	4	
12AU7	2	
6922	3	
OG3	1	
K1931-	1	
6BC7	2	
6BR8A	3	
12AV7	1	
5642	1	
6CZ5	1	
6BJ8	1	
5AR4	1	
6AS7-GA	1	(Type 6080 is preferred but base clamp tube retainer must be removed)
1N34-A	1	Part Number 2600 1530
Selenium HV Diode (4300 piv)	2	Part Number 2600 2711
Silicon Diode (1N1169/1N1763)	2	
NE-2	1	
3.2V Indicator Lamp (#1490)	2	

c. 2000-Hour Spares (2 years)

The recommended list for one through 5 units is given below. Maintain spares indicated plus one for each oscilloscope in use.

2 of each set of the 500-hour spares list given in paragraph (b) plus the quantities listed as follows:

Capacitors

SYMBOL	QUANTITY	SYMBOL	QUANTITY
C1101	2	C2213	2
C1103	3	C2217	2
C1109	5	C3102	5
C1219	2	C3108	2
C1220	3	C3211	6
C2103	3	C3214	4
C2108	2	C3215	4
C2204	3	C3217	4
C2205	5	C3300	4
C2211	3	C3304	4

Lamps

SYMBOL	QUANTITY
DS1101	2
DS3400	2

Electrical Connector

J1101 1

Resistors

1 each of the following components:

R1101	R1132	R2216	R3310
R1102	R1206	R2221	R3111
R1103	R1211	R2222	R3116
R1104	R1215	R2225	R3118
R1105	R1217	R2227	R3119
R1109	R1221	R2228	R3203
R1111	R1222	R2229	R3205
R1115	R1227	R2231	R3224
R1117	R1228	R2233	R3228
R1121	R1229	R2245	R3237
R1122	R2106	R3101	R3300
R1127	R2113	R3105	R3301
R1128	R2124	R3106	R3402
R1129	R2212	R3107	R3405
R1131		R3108	

Transformers

SYMBOL	QUANTITY
T3100	2
T3200	1

Switches

Stock only one each of the following switches for each 3 units being maintained:

S110, S120, S210, S211, S220, S4000, S4100, S4200

NOTE: Should a particular switch receive more than normal use in certain applications (such as the X VOLTS/CM switch used for continued single-sweep rearming) then the quantity stocked of that particular switch should be doubled.

d. Miscellaneous

The following items may be stocked in quantities of one for each two units being maintained.

NAME	QUANTITY	PART NUMBER
Scale	1	4500 8683
Links	2	0903 1051
Screws	4	6008 1460
Knob	1	4500 9953
Knob	1	4500 8903
Knob	1	8700 1132
Knob	1	4500 8945
Power Cord	1	5026 9641

The quantities of spare parts given in the preceding paragraphs are intended for industrial and military duty under normal environment and heavy-use conditions. It is suggested that the maintenance engineer evaluate:

1. The conditions under which the instruments will be used.
2. The skill of the maintenance technicians.
3. Other similar items on hand.
4. The effect of procurement time of spares of your organization.

It is recommended that inventories of spare parts outlined above be adjusted according to the requirements of your own laboratory or plant.

5. TYPE 4002 ACCESSORY KIT

Available is the Du Mont Type 4002 Accessory Kit. It includes the Scale, Test Probe, and Hood.

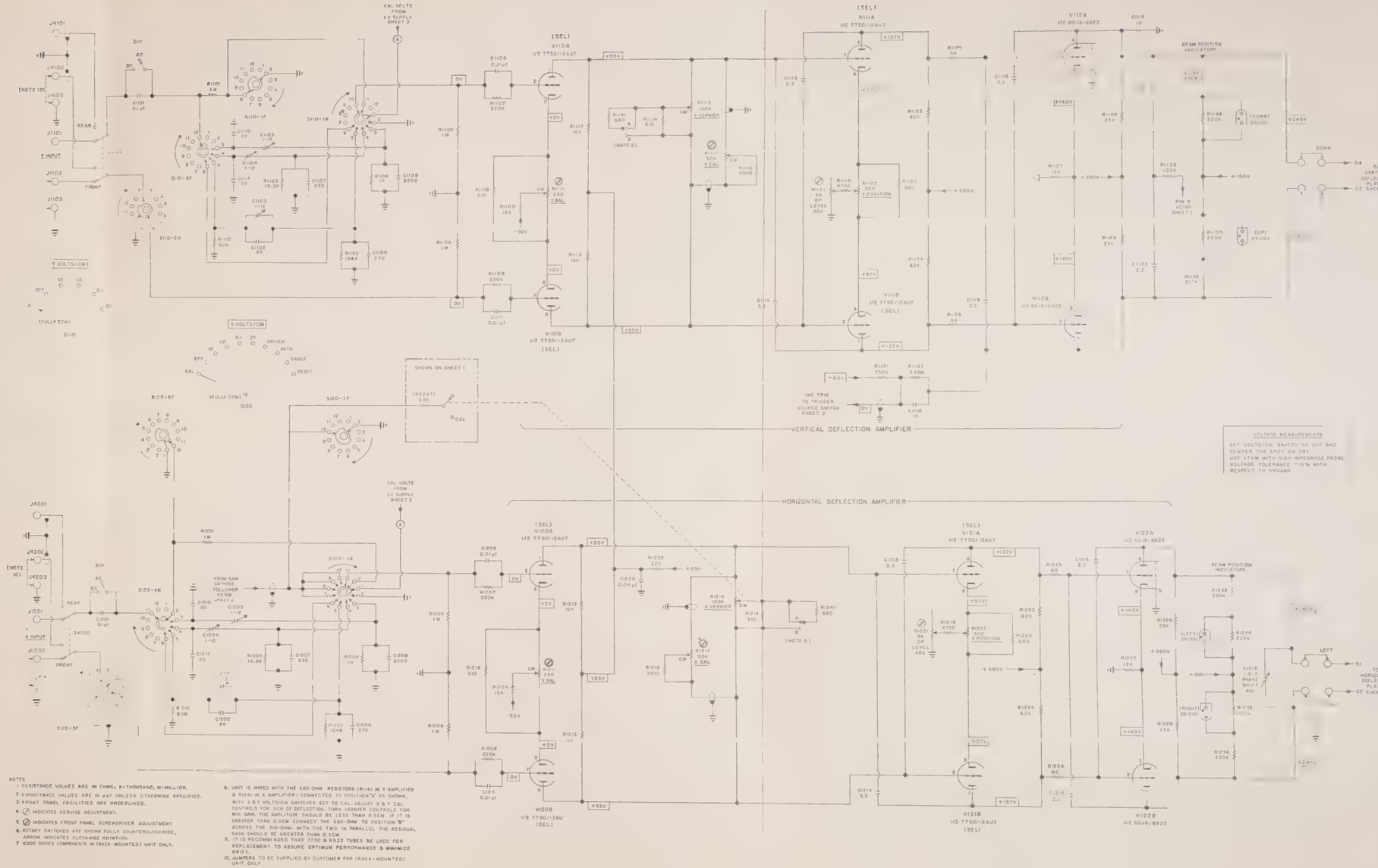
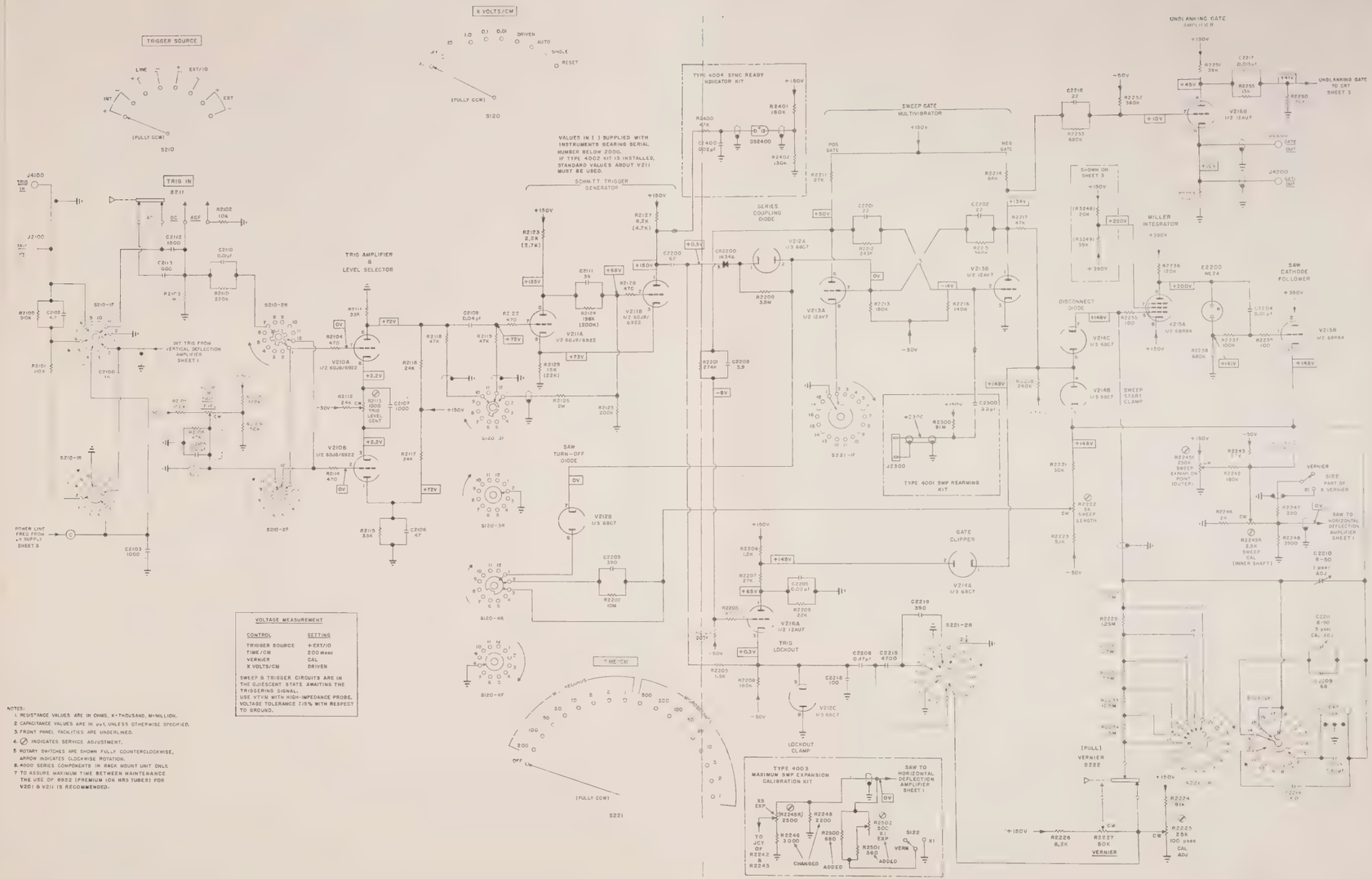

VERTICAL DEFLECTION AMPLIFIER
HORIZONTAL DEFLECTION AMPLIFIER
VOLTAGE MEASUREMENTS
SET VOLTS/CM SWITCH TO OFF AND CENTER THE SPOT ON CRT. USE VTVM WITH HIGH-IMPEDANCE PROBE. VOLTAGE TOLERANCE ±15% WITH RESPECT TO GROUND
NOTES
1. RESISTANCE VALUES ARE IN OHMS; K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN μμf UNLESS OTHERWISE SPECIFIED.
3. FRONT PANEL FACILITIES ARE UNDERLINED.
4. ⊘ INDICATES SERVICE ADJUSTMENT.
5. ⊘ INDICATES FRONT PANEL SCREWDRIVER ADJUSTMENT
6. ROTARY SWITCHES ARE SHOWN FULLY COUNTERCLOCKWISE, ARROW INDICATES CLOCKWISE ROTATION.
7. 4000 SERIES COMPONENTS IN (RACK-MOUNTED) UNIT ONLY.
8. UNIT IS WIRED WITH THE 680-OHM RESISTORS (R1141 IN Y AMPLIFIER & R1241 IN X AMPLIFIER) CONNECTED TO POSITION "A" AS SHOWN, WITH X & Y VOLTS/CM SWITCHES SET TO CAL. ADJUST X & Y CAL CONTROLS FOR 5CM OF DEFLECTION. TURN VERNIER CONTROLS FOR MIN GAIN. THE AMPLITUDE SHOULD BE LESS THAN 0.5CM. IF IT IS GREATER THAN 0.5CM CONNECT THE 680-OHM TO POSITION "B" ACROSS THE 510-OHM. WITH THE TWO IN PARALLEL THE RESIDUAL GAIN SHOULD BE GREATER THAN 0.3CM.
9. IT IS RECOMMENDED THAT 7730 & 6922 TUBES BE USED FOR REPLACEMENT TO ASSURE OPTIMUM PERFORMANCE & MINIMIZE DRIFT.
10. JUMPERS TO BE SUPPLIED BY CUSTOMER FOR (RACK-MOUNTED) UNIT ONLY

FIGURE 6-1. X & Y DEFLECTION AMPLIFIERS

REFERENCE DRAWING 9800 2101-4, SHEET 1 OF 3



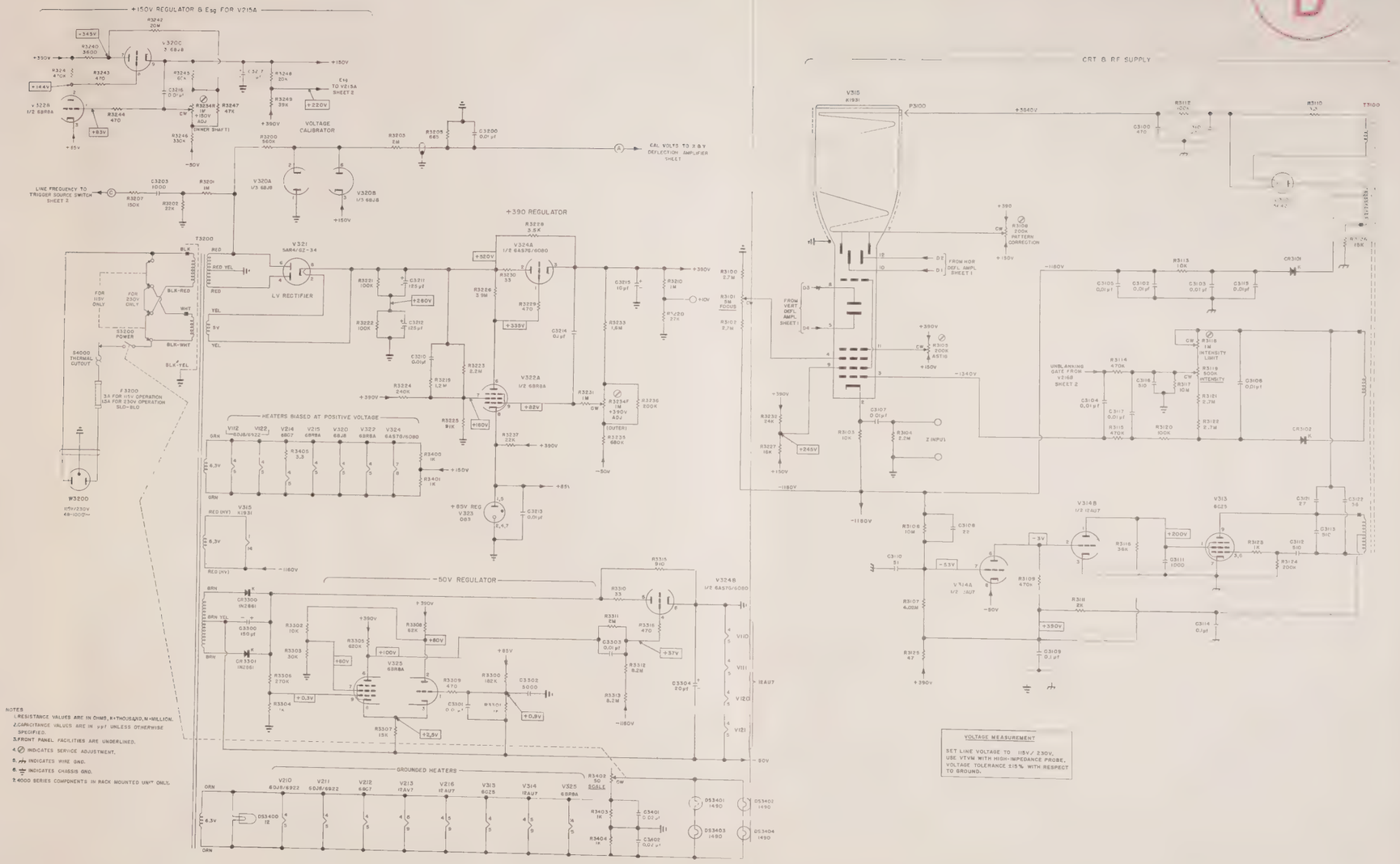
VOLTAGE MEASUREMENT	
CONTROL	SETTING
TRIGGER SOURCE	+EXT/10
TIME/CM	200 msec
VERNIER	CAL
X VOLTS/CM	DRIVEN

SWEEP & TRIGGER CIRCUITS ARE IN THE QUIESCENT STATE AWAITING THE TRIGGERING SIGNAL.
USE VTVM WITH HIGH-IMPEDANCE PROBE. VOLTAGE TOLERANCE ±15% WITH RESPECT TO GROUND.

NOTES:
1. RESISTANCE VALUES ARE IN OHMS, K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN µµf, UNLESS OTHERWISE SPECIFIED.
3. FRONT PANEL FACILITIES ARE UNDERLINED.
4. ⊘ INDICATES SERVICE ADJUSTMENT.
5. ROTARY SWITCHES ARE SHOWN FULLY COUNTERCLOCKWISE, ARROW INDICATES CLOCKWISE ROTATION.
6. 4000 SERIES COMPONENTS IN RACK MOUNT UNIT ONLY.
7. TO ASSURE MAXIMUM TIME BETWEEN MAINTENANCE THE USE OF 6922 (PREMIUM 10K HRS TUBES) FOR V201 & V211 IS RECOMMENDED.

FIGURE 6-2. TRIGGER AND SWEEP CIRCUITS

REFERENCE DRAWING 9800 2101-4, SHEET 2 OF 3


+150V REGULATOR & Esg FOR V215A
+390 REGULATOR
-50V REGULATOR
HEATERS BIASED AT POSITIVE VOLTAGE
GROUNDED HEATERS
CRT & RF SUPPLY
LV RECTIFIER
VOLTAGE CALIBRATOR
+85V REG
FROM VERT. DEFL. AMPL. SHEET 1
FROM HOR DEFL. AMPL. SHEET 1
CAL VOLTS TO X & Y DEFLECTION AMPLIFIER SHEET
LINE FREQUENCY TO TRIGGER SOURCE SWITCH SHEET 2
UNBLANKING GATE FROM V216B SHEET 2
TO V215A SHEET 2
S4000 THERMAL CUTOUT
S3200 POWER
F3200
3A FOR 115V OPERATION
1.5A FOR 230V OPERATION
SLO-BLO
W3200
115V/230V
48-1000~
VOLTAGE MEASUREMENT
SET LINE VOLTAGE TO 115V / 230V.
USE VTVM WITH HIGH-IMPEDANCE PROBE.
VOLTAGE TOLERANCE ±5% WITH RESPECT TO GROUND.
NOTES
1. RESISTANCE VALUES ARE IN OHMS, K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN µµf UNLESS OTHERWISE SPECIFIED.
3. FRONT PANEL FACILITIES ARE UNDERLINED.
4. ⊘ INDICATES SERVICE ADJUSTMENT.
5. ⏚ INDICATES WIRE GND.
6. ⏚ INDICATES CHASSIS GND.
7. 4000 SERIES COMPONENTS IN RACK MOUNTED UNIT ONLY.

B

FIGURE 6-3. CRT, LOW AND HIGH VOLTAGE POWER SUPPLIES

REFERENCE DRAWING 9800 2101-4, SHEET 3 OF 3

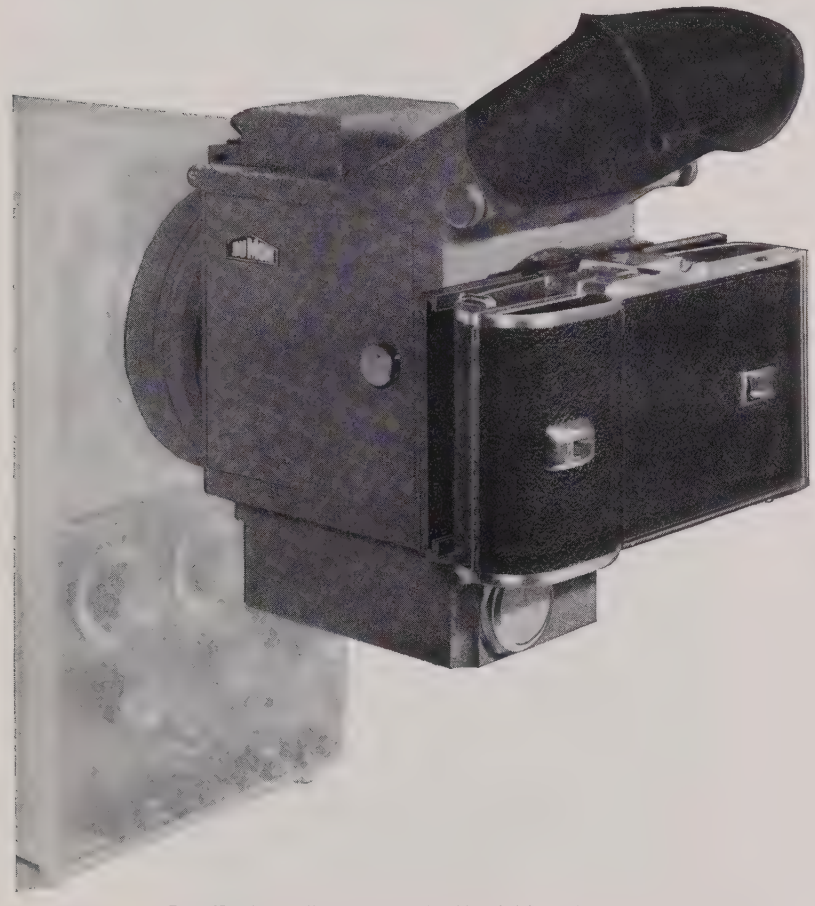
product of the pioneer

DU MONT INSTRUMENTS

precision electronics is our business

OSCILLOSCOPE CAMERA TYPE 450

Type 450 Oscilloscope Camera



Type 450 shown with accessory solenoid and data card assembly.

The Type 450 Oscilloscope Camera is an entirely new camera in every concept from versatility in recording to simplicity in operation. Interchangeability of camera backs and lenses enable the operator to obtain permanent records in any sizes from 4″ x 5″ to 35 mm, in a multiplicity of object-to-image ratios — on regular or Polaroid film and print products. A sliding back with detented locking positions permit precision-spaced multiple exposures per frame. All lenses include synchro-shutters for arming oscilloscopes with a remote single sweep feature. For remote operation a solenoid power pack is available. Focusing by a helical rack and pinion mechanism enhances precision results, and keeps optical axis perpendicular to film plane. The light-weight, all metal camera is firmly mounted by a ratchet type mounting clamp.

PRINTED IN U.S.A.

Technical Resume

- Interchangeable lenses — full scale reproduction and approx. image ratios of 2:1 and 6:1
- Interchangeable backs
- Positive detented positions for multiple exposures
- All lenses equipped with synchro shutters and external electrical connectors
- Direct viewing while recording
- Ratchet operated mounting clamp
- Lightweight, all metal construction
- Large access door for lens and aperture settings
- Helical rack & pinion focusing mechanism
- Cameras may be triggered in tandem
- Camera may be used to rearm single sweeps for operational simplicity
- Accessories available for remote operation, rapid sequential recording and digital readout recording.

PRICE: $445.00
f.o.b. Clifton, N. J.

For camera with 1.1 f/1.9 lens and polaroid back.

INSTRUMENT SALES DEPARTMENT

Allen B. Du Mont

ALLEN B. DU MONT LABORATORIES, CLIFTON, N. J., U. S. A.
Divisions of FAIRCHILD CAMERA AND INSTRUMENT CORP.
DU MONT INTERNATIONAL DIVISION, 515 MADISON AVE., NEW YORK 22, N. Y.

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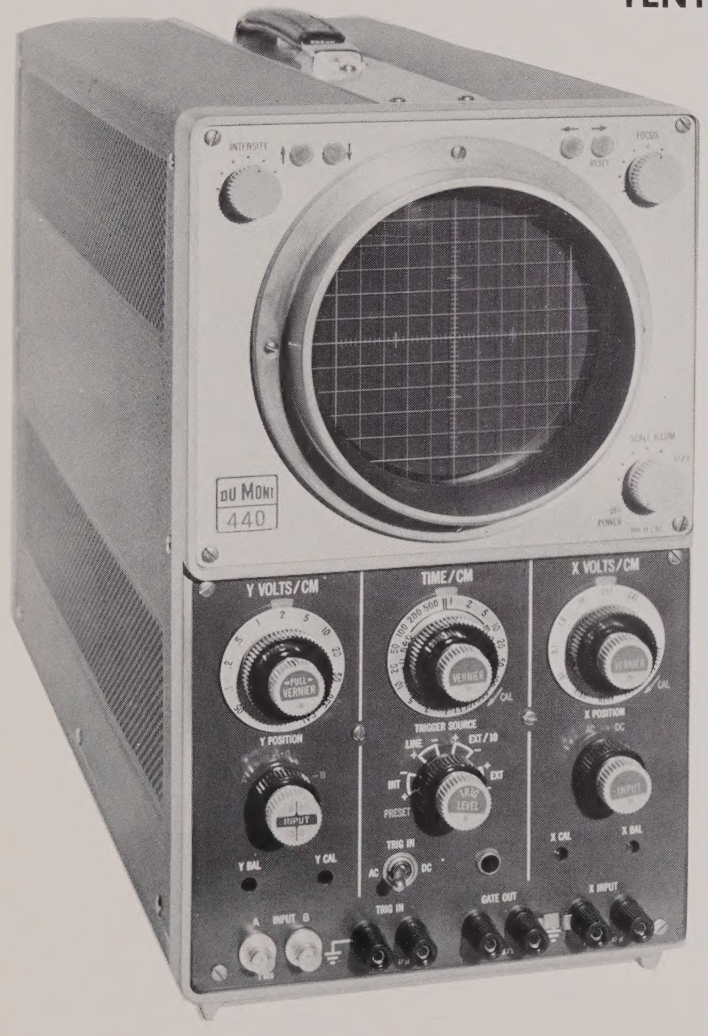
DU MONT INSTRUMENTS

precision electronics is our business

OSCILLOSCOPE TYPE 440 & 440R

TENTATIVE



Technical Resume

- DC to 5 mc bandwidth in vertical amplifier
- Sensitivity 50 mv/cm to 500 volts full scale
- Sweep speeds continuous between 0.2 usec/cm to 10 sec full scale
- Rise time 0.08 usec or less
- Selection of auto, driven or single sweep
- Balanced input on all ranges
- 500 kc bandwidth on horizontal axis
- Handcrafted circuitry

5 MC OSCILLOSCOPE

The Type 440 is an economically priced Oscilloscope offering all of the advantages of general purpose oscilloscopes, but with the bandwidth extended to 5 mc for precision investigations in the range approaching high-frequency. The accelerating potential is stepped up to 5 kv for brighter displays for oscilloscopes in this classification. The 17 sweep speeds provided are accurately calibrated from 1 usec/cm to 200 milliseconds to lock in virtually any recurring phenomena, while a sweep vernier permits continuous adjustment between the calibrated steps—and extends the sweep range to 10 seconds full scale for detailed study of intermittently recurring phenomena. A sweep expander extends the fastest sweep range to 0.2 usec/cm. A sweep arming feature sets up the triggering of a single sweep; highly useful, for example, in capturing transients. A 10 step attenuator permits observation of any signal between 50 mv/cm to 500 volts full scale—at rise times of 0.08 usec or less. The attenuator is fully balanced throughout every step and compensated for use with probes.

DU MONT

Instrument Sales Department
Allen B. Du Mont Laboratories, 750 Bloomfield Ave., Clifton, N. J.
Divisions of FAIRCHILD CAMERA AND INSTRUMENT CORP.
Du Mont International Division, 515 Madison Ave., New York 22, N. Y.

TENTATIVE SPECIFICATIONS, TYPE 440 and 440R

VERTICAL AMPLIFIER

Bandwidth
DC Coupled: dc to 5 mc
AC Coupled: 5 cps to 5 mc
Rise time: Less than .08 usec

Sensitivity
50 mv/cm to 100 v/cm. 10 steps in 1, 2, 5 sequence. Off and calibrate positions provided.
Vernier has push switch position for calibrated gain. Vernier permits continuous sensitivity adjustment between attenuator steps and extends the 50 v/cm range.
An off position for d-c balancing is included on the attenuator.

Internal Calibrator
Line frequency trapezoidal wave. Accuracy nominally 1%, always within 2%.

Input Connectors
Two BNC shielded connectors provided for Y input. Selector switch permits choice of single ended input through either connector, or balanced input through both.

Input Impedance
1 megohm (2 megohms available), constant within ±2% at all attenuator settings for single ended operation. Nominally 47 uuf; constant within ±3% from range to range. AC coupling capacitor blocks 600 volts dc plus peak ac.

Balanced Input
Balanced input available at all attenuator settings. Input impedance 2 megohms (4 megohms available) shunted by less than 30 uuf.

Common Mode Rejection
Nominally 120:1; always better than 100:1 on 50 mv/cm range, always better than 50:1 on all other ranges.

Stability
Nominally less than 1 mv drift per hour; always less than 3 mv drift per hour.

Positioning Range
2 times full scale

HORIZONTAL AMPLIFIER

Bandwidth:
DC coupled: dc to 450 kc
AC coupled: 2 cps to 450 kc
Rise time: Nominally 0.8 usec

Sensitivity
10 mv/cm to 100 v/cm. Four decade attenuator steps from 10 mv/cm to 10 v/cm, ±2%.
Vernier has preset switch position for calibrated gain and a minimum range from greater than calibrated gain through 10 to 1 to permit continuous sensitivity adjustment between attenuator steps and extends the 10 v/cm range to 100 v/cm. An off position for d-c balancing is included on the attenuator.

Internal Calibrator
Same as for vertical amplifier.

Input Connectors
Combination binding posts on ¾ inch centers provide balanced input; a connector strap is provided for single ended operation.

Phase Shift
Variable capacitor in X channel provided for adjustment of phase response.

Input Impedance
1 megohm ±3% at all settings. Nominally 47 uuf; constant within ±5% from range to range. AC coupling capacitor blocks 600 volts dc plus peak ac.

Balanced Input
Vernier adjustable from 10 mv/cm to 100 mv/cm.
Input impedance 2 megohms shunted by less than 40 uuf.

Common Mode Rejection
Nominally 120:1, always better than 100:1.

Stability
Nominally less than 1 mv/hr drift, always less than 3 mv/hr.

Positioning Range
5 times full scale.

Time Base
Sweep rate 1 usec/cm to 200 milliseconds/cm in 17 calibrated steps; 1, 2, 5 and 10 step sequence. An off position is included. Vernier permits continuous adjustment between steps, and extends range to 10 second maximum sweep time.

Sweep Expansion
Expandable about center of CRT by greater than 5 times. Any section of expanded trace can be positioned on screen.

Synchronization
Coupling: AC — 80 cps to 1 mc minimum.
DC — Direct coupled to preserve very low frequencies or the scale oriented sync level.
ACF — To reduce effects of low frequency components in triggering signal. 10 kc to 1 mc.

Slope Leveling
Positive or negative polarity slope triggering is available. A preset position at optimum trigger point included.

External
0.25 v p-p from dc to approx. 300 kc will trigger the sweep.

Internal
Syncs on ½ cm of vertical signal.

Line Synchronization
May be selected in either polarity (slope) and the triggering point may be phased with the trigger level control.

Automatic Triggering
Available in conjunction with preset or vernier trigger leveling on internal, external and line trigger sources. Base line is recurrent at approx. 50 cps.

Single Sweep
The single sweep mode permits but one driven sweep of the time base to appear on the CRT until the sweep is reset.

GENERAL

Cathode-Ray Tube
K1931, operating 5 kv. P1 phosphor normally supplied, but P2, P7 and P11 are also available. Aluminized CRT optional.

Electronic Shutter
Controlled exposure for multiple trace displays through use of driven sweep. This feature may be switched out by setting sweep to off position.

CRT Direct Inputs
Terminals at rear provide vertical and horizontal sensitivity 10 v/cm to 14 v/cm. Positive pulse of 15 volts blanks trace for Z-axis inputs.

Mechanical Dimensions

	440		440R	
Width	8¾"	(22.3 cm)	19"	(48.4 cm)
Height	15½"	(39.4 cm)	7"	(17.8 cm)
Length	23¼"	(59.2 cm)	28⅛"	(58.7 cm)*
Weight	45 lbs.	(20.4 kg)	45 lbs.	(20.4 kg)

* 22" behind panel

Ambient Temperature
0°C to 40°C operating; —20°C to 75°C storage. Rack unit incorporates thermal cutout protection.

Utility Signals
5-volt negative gate, coincident with sweep time, available on a front panel binding post. Negative side of this signal may be used to adjust attenuator probe compensation.
A 10-volt, high impedance, dc voltage is available at the rear panel to facilitate triggering from external contact closures.

Beam Position Indicators
Four indicator lights on front panel indicate off-screen beam position.

Rear Terminals On Rack Unit
Front panel input terminals are duplicated at the rear of the 440R. Front/rear switching provided on the front panel.

Power Requirement
115/230 volts ±10% 48 to 1000 cps.
Power at 60 cps approximately 250 VA
approximately 230 watts.

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